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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION 5 77 WEST JACKSON BOULEVARD CHICAGO, IL 60604-3590

MEMORANDUM

DATE:

February 10, 2005

SUBJECT:

Ellsworth Industrial Park (05B52A) - Screening Vapor Intrusion

Analysis (1st iteration)

FROM:

Ross del Rosario, RPM

EPA Region 5 Records Ctr.

265608

TO:

Addressees

Following our February 1, 2005 meeting regarding Ellsworth Industrial Park, I instructed one of our in-house risk assessors, Arunas Draugelis, to conduct a screening analysis on vapor intrusion (VI) at downgradient residential areas of the site. The analysis, in Excel spreadsheet, used the latest Johnson & Ettinger (J & E) Vapor Intrusion Model for groundwater (Version 3.1, February 2004). Three (3) contaminants of concern were evaluated: 1) Trichlorethene (TCE) 2) Perchloroethene (PCE) and 3) 1,1,1 Trichloroethane (1,1,1 TCA). The results of the analysis, based on the highest values observed for these contaminants, are as follows:

- Potential incremental risk from VI to indoor air associated with TCE was 7.8 x 10⁻⁶;
- 2. The corresponding value for PCE was 5.2 x 10⁻⁷; and
- 3. For 1,1,1 TCA, no risk value was given by the analysis. The IRIS database designated this compound as a non-carcinogen (although the drinking water tables rated this compound as a "possible human carcinogen"). A hazard index (HI) of 4.9 x 10⁻⁵ was calculated, significantly less than the value of 1 that we use for reference.

Conclusion: Based on the results above, the potential incremental cancer risks associated with TCE and PCE in the groundwater below the homes is expected to be negligible. For reference, the draft vapor intrusion guidance (2002) recommended using 1 x 10⁻⁵ as the basis for taking follow-up action on VI. Consequently, further action on VI is not warranted at this point. Further VI investigation is already planned as part of the future groundwater operable unit at the site. Similarly, in 2002, IEPA concluded (through its contractor, Parsons) that VI risks for the neighboring Lockformer site in Lisle, Illinois were negligible (see attached).

Qualifier(s): The data used in the calculation is rather limited and the site geology is not fully defined. A default value was used in cases where such site-specific data (e.g.,

porosity, temperature, etc.) was not available. While the use of default values is allowed in the analysis, using site-specific data is preferable.

Data Input: The following assumptions were made in the analysis:

- 1. The analysis used the highest concentration found for each of the above contaminants at the residential wells sampled in 2001-2002 14 ug/l for PCE, 16.6 ug/l for TCE, and 6.3 ug/l for TCA. (Note: The specific identities and addresses of these homes are still considered confidential and should be handled accordingly);
- Data from the southernmost monitoring well network at the industrial park (BD-16D through BD-18D), located just north of the downgradient homes, indicated relatively similar concentrations for TCE, PCE, and 1,1,1 TCA (see attached). Using these values, incremental cancer risks from VI for TCE and PCE were calculated to be 7.2 x 10⁻⁶ and 1.2 x 10⁻⁸, respectively (see attached). These figures compare favorably with the calculations made for the residential wells using the highest concentrations found for these contaminants;
- 3. A depth to water value of 100 feet was used after averaging the actual values found in previous surveys (see attached). It is noted that, while there may be shallower aquifers present in the residential area, the presence of the thick clay layer and relatively low levels of TCE and PCE would be unlikely to change the conclusion reached above;
- 4. The analysis took into account a 50-60 feet-thick clay layer overlying the water table in the residential area. This information was taken from drilling/boring log data available to this office. For the industrial park, boring logs from the monitoring wells described a 25-35 foot clay layer overlying a 10-foot sand and gravel layer; and
- 5. The analysis assumed that a silty clay layer lay directly above the residential wells, with a corresponding porosity value (0.43). If the actual stratigraphy is different, the porosity would also change and could affect the results numerically. As with Item #3 above, the authors of this analysis don't believe such a change will fundamentally alter the conclusion.

If there are any questions related to this matter, please contact me at (312) 886-6195.

Attachments

Addressees: Rick Karl

Wendy Carney Jim Mayka

Rosita Clarke-Moreno

Tom Krueger Fred Nika, IEPA Arunas Draugelis



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION5 77 WEST JACKSON BOULEVARD CHICAGO, IL 60604-3590

REPLY TO THE ATTENTION OF

MEMORANDUM

DATE:

February 10, 2005

SUBJECT:

Screening Vapor Intrusion Analysis - Ellsworth Industrial Park, Downers Grove, IL

(Site ID B52A)

FROM:

Arunas K. Draugelis, Toxicologist

TO:

Ross del Rosario, RPM

As per you Memorandum of February 2, 2005, and February 10, 2005, I used the information and data supplied to screen the effects from TCE, PCE and 1,1,1, TCA for vapor intrusion into residential homes. I used the Johnson and Ettinger (J&E) Vapor Intrusion Model, Ground Water-Advanced Version 3.1; 02/04 and have attached the Data Entry Sheets and Results Sheets for TCE, PCE and 1,1,1-TCA.

The results seem to indicate that the incremental risk from these chemicals through the vapor intrusion pathway would be negligible and would not warrant any action from this pathway.

DATA ENTRY SHEET

GW-ADV Version 3.1; 02/04	CALCULATE RIS	SK-BASED GROU	INDWATER CON	ICENTRATION	(enter "X" in "YES"	, pox)						
Reset to		YES	OR]								
Defaults	CALCULATE INC	CREMENTAL RIS	KS FROM ACTU	AL GROUNDW	ATER CONCENTE	RATION (enter "X" in	"YES" box and initial	groundwater cond	: below)			
		YES	×									
	Chemical CAS No	ENTER Initial groundwater conc.										
	(numbers only, no dashes)	C _w (μ ց /L)			Chemical							
	79016	1 66E+01]		Trichloroethyle	ene						
	ENTER	ENTER Depth	ENTER	ENTER Totals mu	ENTER	ENTER of L _{w1} (cell G28)	ENTER	ENTER	ENTER Soil		ENTER]
MORE +	Average soil/ groundwater temperature, T _S	below grade to bottom of enclosed space floor, Le	Depth below grade to water table, Lw1	Thickness of soil stratum A,	h _B	Thickness of soil stratum C, (Enter value or 0) h _c	Soil stratum directly above water table,	SCS soil type directly above	stratum A SCS soil type (used to estimate soil vapor	OR	User-defined stratum A soil vapor permeability, k	
	(°C)	(cm)	(cm)	(cm)	(cm)	(cm)	(Enter A, B, or C)	water table	permeability)		(cm²)	<u> </u>
	10	200	3200	200	1500	1500	c	sc			1 00E-08]
MORE +	Stratum A SCS Soil type Lookup Soil Parameters	ENTER Stratum A soli dry bulk density,	Stratum A soil total porosity, n ^A	ENTER Stratum A soil water-filled porosity, θ_n^A (cm³/cm³)	ENTER Stratum B SCS soil type Lookup Soil Paramotore	ENTER Stratum B soil dry bulk density, Pt (g/cm³)	ENTER Stratum B soil total porosity, n ⁸ (unitless)	ENTER Stratum B soil water-filled porosity, θ_n^B (cm^3/cm^3)	Stratum C SCS Soil type	Stratum C soil dry bulk density,	ENTER Stratum C soil total porosity, n ^c	ENTER Stratum C soil water-filled porosity,
		(g/cm ⁻)	(unitless)							(g/cm²)	(unitless)	(cm³/cm³)
MORE	ENTER Enclosed	1 50	0 430 ENTER Enclosed	0 18 ENTER Enclosed	ENTER	15 ENTER	0 43 ENTER	0.215	ENTER Average vapor	1,5	0.43	0 197
<u> </u>	space floor thickness, L _{cret} e	Soil-bidg pressure differential, ΔP	space floor length, Le	space floor width, W _f	Enclosed space height, H _e (cm)	Floor-wall seam crack width, w (cm)	Indoor air exchange rate, ER	Le	flow rate into bidg. OR save blank to calcula Q _{sob}	to.		
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MORE →	ENTER Averaging time for carcinogens, AT _C	ENTER Averaging time for noncarcinogens, AT _{NC}	ENTER Exposure duration, ED	Exposure frequency,	ENTER Target risk for carcinogens, TR	Target hazard quotient for noncardinogens, THQ						
	(yrs)	(yrs)	(yrs)	(days/yr)	(unitless)	(unitless)						
	70	30	30	350	1 0E-06	1						
END						late risk-based concentration						

RESULTS SHEET

79016/70€

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

INCREMENTAL RISK CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure g:oundwater conc noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)	risk from vapor intrusion to indoor air, carcinogen (unitless)	quotient from vapor intrusion to indoor air, noncarcinogen (unitiess)
NA NA	NA .	NA NA	1.47E+06	NA	7.8E-06	4.1E-03

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

GW-ADV Version 3.1; 02/04	CALCULATE RIS	SK-BASED GROU	INDWATER CON	ICENTRATION	(enter "X" in "YES"	box)						
Reset to		YES	OR]								
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	ENTER	YES Enter	x	j								
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	127184	1 40E+01]		Tetrachloroethy	lene						
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MORE	Average	below grade			Thickness	Thickness			stratum A		User-defined	ŀ
<u> </u>	soil/	ta bottom	Depth	Thickness	of soil	of soil	Soil		scs		stratum A	[
	groundwater	of enclosed	below grade	of soil	stratum B,	stratum C,	stratum	SCS	soil type	0.5	soil vapor	
	temperature, $T_{ m S}$	space floor, Lr	to water table, ليب	stratum A.	(Entervalue or 0)	(Enter value or 0) h ₀	directly above water table,	soil type directly above	(used to estimate soil vapor	OR	permeability,	
	(°C)	(cm)	(cm)	(cm)	(cm)	(cm)	(Enter A, B, or C)	water table	permeability)		k, (cm²)	
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		_				_				•		
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	ENTER Enclosed space floor thickness, Locat (cm) 10 ENTER Averaging	(g/cm³) 1 50 ENTER Soil-bldg pressure differential, ΔP (g/cm·s²) 40 ENTER Averaging	(unitless) O 430 ENTER Enclosed space floor length, L ₄ (cm) 1000 ENTER	(cm²/cm²) 0 18 ENTER Enclosed space floor width, W ₈ (cm) 1000 ENTER	ENTER Enclosed space height, He (cm) 365 ENTER	(g/cm³) 1 5 ENTER Floor-wall seam crack width, w (cm) 0 1 ENTER Targel hazard	(unitless) 0 43 ENTER Indoor air exchange rate, ER (1/h)	(cm³/cm³)	ENTER Average vapor flow rate into bidg. OR eave blank to calcula Quest (Um)	(g/cm³)	(unitiess)	(cm³/cm³)
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MORE	ENTER Enclosed space floor thickness, Lorace (cm) 10 ENTER Averaging time for carcinogens,	(g/cm³) 1.50 ENTER Soil-bldg pressure differential, ΔP (g/cm·s²) 40 ENTER Averaging time for noncarcinogens.	(unitless) O 430 ENTER Enclosed space floor length, L ₄ (cm) 1000 ENTER	(cm²/cm²) 0 18 ENTER Enclosed space floor width, W ₈ (cm) 1000 ENTER	ENTER Enclosed space height, He (cm) 365 ENTER	(g/cm³) 1 5 ENTER Floor-wall searn crack width, w (cm) 0 1 ENTER Targel hazard	(unitless) 0 43 ENTER Indoor air exchange rate, ER (1/h)	(cm³/cm³)	ENTER Average vapor flow rate into bidg. OR eave blank to calcula Quest (Um)	(g/cm³)	(unitiess)	(cm³/cm³)
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RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

INCREMENTAL RISK CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)	risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA NA	NA NA	NA	2.00E+05	NA	5.2E-07	3.4E-04

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

GW-ADV Version 3.1; 02/04	CALCULATE RIS	SK-BASED GROU	UNDWATER CON	ICENTRATION	(enter "X" in "YES"	box)						
Reset to		YES	OR]								
Defaults	CALCULATE IN	CREMENTAL RIS		AL GROUNDW	ATER CONCENTE	RATION (enter "X" in	"YES" box and initial	groundwater cond	c. below)			
		YES	Х]								
	ENTER	ENTER initial										
	Chemical	groundwater										
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	no dashes)	(μ g /L)	-		Chemical		•					
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<u> </u>	Soil/	to bottom	Depth	Thickness	of soil	of soil	Soil		scs		stratum A	ł
	groundwater	of enclosed	below grade	of soil	stratum B,	stratum C,	stratum	scs	soil type		soil vapor	1
	temperature,	space floor,	to water table.	stratum A,	(Enter value or 0)		directly above water table,	soil type	(used to estimate	OR	permeability,	
	T _s	<u>L</u> r	L _{w1}	h _A	h _i ;	h _e		directly above	solf vapor		, K,	ĺ
	(^C)	(cm)	(cm)	(cm)	(cm)	(cm)	(Enter A, B, or C)	water table	permeability)		(cm²)	-
	10	200	3200	200	1500	1500	c	SC			1 00E-08]
	ENTER	ENTER	ENTER	ENTER	ENTER	ENTER	ENTER	ENTER	ENTER	ENTER	FMTFR	ENTER
MORE	ENTER Stratum A	ENTER Stratum A	ENTER Stratum A	Stratum A	Stratum B	Stratum B	Stratum B	ENTER Stratum B	ENTER Stratum C	ENTER Stratum C	ENTER Stratum C	ENTER Stratum C
MORE +	Stratum A SCS	Stratum A soil dry	Stratum A soil total	Stratum A soil water-filled	Stratum B SCS	Stratum B soil dry	Stratum B soil total	Stratum B soil water-filled	Stratum C SCS	Stratum C soil dry	Stratum C soil total	Stratum C soil water-filled
	Stratum A SCS soil type	Stratum A soil dry bulk density,	Stratum A soil total porosity,	Stratum A soil water-filled porosity,	Stratum B SCS soil type	Stratum B soil dry bulk density,	Stratum B soil total porosity,	Stratum B soil water-filled porosity,	Stratum C SCS soil type	Stratum C soil dry bulk density,	Stratum C soil total porosity,	Stratum C soil water-filled porosity,
	Stratum A SCS soil type Lookup Soil	Stratum A soil dry bulk density,	Stratum A soil total porosity, n ^A	Stratum A soil water-filled porosity, $\theta_n^{\ A}$	Stratum B SCS	Stratum B soil dry bulk density, ρ_e^B	Stratum B soil total porosity, n ⁸	Stratum B soil water-filled porosity, $\theta_n^{\ B}$	Stratum C SCS soil type	Stratum C soil dry bulk density, Pb ^C	Stratum C soil total	Stratum C soil water-filled porosity, θ_n^C
	Stratum A SCS soil type	Stratum A soil dry bulk density,	Stratum A soil total porosity,	Stratum A soil water-filled porosity,	Stratum B SCS soil type	Stratum B soil dry bulk density,	Stratum B soil total porosity,	Stratum B soil water-filled porosity,	Stratum C SCS soil type	Stratum C soil dry bulk density,	Stratum C soil total porosity,	Stratum C soil water-filled porosity,
	Stratum A SCS soil type Lookup Soil	Stratum A soil dry bulk density,	Stratum A soil total porosity, n ^A	Stratum A soil water-filled porosity, $\theta_n^{\ A}$	Stratum B SCS soil type	Stratum B soil dry bulk density, ρ_e^B	Stratum B soil total porosity, n ⁸	Stratum B soil water-filled porosity, $\theta_n^{\ B}$	Stratum C SCS soil type	Stratum C soil dry bulk density, Pb ^C	Stratum C soil total porosity, n ^C	Stratum C soil water-filled porosity, θ_n^C
	Stratum A SCS soil type Lookup Soil	Stratum A soil dry bulk density, ρ _b ^A (g/cm ³)	Stratum A soil total porosity, n ^A (unitless) 0.430 ENTER	Stratum A soil water-filled porosity,	Stratum B SCS soil type	Stratum B soil dry bulk density, p _t ^B (g/cm ⁻)	Stratum B soil total porosity, n ⁸ (unitless)	Stratum B soil water-filled porosity, $\theta_n^{\ B}$ (cm ³ /cm ³)	Stratum C SCS soil type	Stratum C soil dry bulk density, p _b ^C (g/cm ³)	Stratum C soil total porosity, n ^C (unitless)	Stratum C soil water-filled porosity, θ_n^C (cm ³ /cm ³)
. ↓	Stratum A SCS soil type Lookup Soil Paranetors ENTER Enclosed	Stratum A soil dry bulk density, \$\rho_b^A\$ (g/cm²) 1.50 ENTER	Stratum A soil total porosity, n ^A (unitless) 0.430 ENTER Enclosed	Stratum A soil water-filled porosity,	Stratum B SCS SOII type Lookup Soil Parameters	Stratum B soil dry bulk density, \$\rho_{\text{B}}^{8}\$ (g/cm^2)	Stratum B soil total porosity, n ⁶ (unitless) 0.43 ENTER	Stratum B soil water-filled porosity, $\theta_n^{\ B}$ (cm ³ /cm ³)	Stratum C SCS soll type Lookup Soil Peremeters ENTER Average vapor	Stratum C soil dry bulk density, p _b ^C (g/cm ³)	Stratum C soil total porosity, n ^C (unitless)	Stratum C soil water-filled porosity, θ_n^C (cm ³ /cm ³)
₩.	Stratum A SCS soil type Lookup Soil Paramotors ENTER Enclosed space	Stratum A soil dry bulk density, Po A (g/cm²) 1.50 ENTER Soil-bldg	Stratum A soil total porosity, n^A (unitless) 0.430 ENTER Enclosed space	Stratum A Soil water-filled porosity, θ, ^ (cm²/cm²) 0 18 ENTER Enclosed space	Stratum B SCS soil type Lookup Soil Parametern ENTER Enclosed	Stratum B soil dry bulk density, \$\rho_c^B\$ (g/cm^3) 15 ENTER	Stratum B soil total porosity, n ⁸ (unitiess) 0.43 ENTER	Stratum B soil water-filled porosity, $\theta_n^{\ B}$ (cm ³ /cm ³)	Stratum C SCS soll type Lookup Soll Parameters ENTER Average vapor flow rate into bidg.	Stratum C soil dry bulk density, p _b ^C (g/cm ³)	Stratum C soil total porosity, n ^C (unitless)	Stratum C soil water-filled porosity, θ_n^C (cm ³ /cm ³)
. ↓	Stratum A SCS soil type Lookup Soil Paramotorn ENTER Enclosed space floor	Stratum A soil dry bulk density, po A (g/cm) 1.50 ENTER Soil-bldg pressure	Stratum A soil total porosity, n^A (unitless) 0.430 ENTER Enclosed space floor	Stratum A Soil water-filled porosity, 8, A (cm³/cm³) 0 18 ENTER Enclosed space floor	Stratum B SCS soil type Lookup Soil Parametern ENTER Enclosed space	Stratum B soil dry bulk density, p _e ^B (g/cm³) 1 5 ENTER Floor-wall seam crack	Stratum B soil total porosity, n ⁸ (unitiess) 0.43 ENTER Indoor air exchange	Stratum B soil water-filled porosity,	Stratum C SCS soil type Lookup Soil Perameters ENTER Average vapor flow rate into bidg. OR	Stratum C soil dry bulk density, Pb ^C (g/cm ³)	Stratum C soil total porosity, n ^C (unitless)	Stratum C soil water-filled porosity, θ_n^C (cm ³ /cm ³)
. ↓	Stratum A SCS soil type Lookup Soil Paramotorn ENTER Enclosed space floor thickness,	Stratum A soil dry bulk density, Po A (g/cm²) 1.50 ENTER Soil-bldg	Stratum A soil total porosity, n ^A (unitless) 0.430 ENTER Enclosed space floor length,	Stratum A Soil water-filled porosity, θ, ^ (cm²/cm²) 0 18 ENTER Enclosed space	Stratum B SCS soil type Lookup Soil Parametern ENTER Enclosed	Stratum B soil dry bulk density, \$\rho_c^B\$ (g/cm^3) 15 ENTER	Stratum B soil total porosity, n ⁸ (unitiess) 0.43 ENTER	Stratum B soil water-filled porosity,	Stratum C SCS soll type Lookup Soil Perameters ENTER Average vapor flow rate into bidg. OR save blank to calculate	Stratum C soil dry bulk density, Pb ^C (g/cm ³)	Stratum C soil total porosity, n ^C (unitless)	Stratum C soil water-filled porosity, θ_n^C (cm ³ /cm ³)
. ↓	Stratum A SCS soil type Lookup Soil Paramotorn ENTER Enclosed space floor	Stratum A soil dry bulk density, p. ^ (g/cm²) 1.50 ENTER Soil-bldg pressure differential,	Stratum A soil total porosity, n^A (unitless) 0.430 ENTER Enclosed space floor	Stratum A soil water-filled poresity, θ, ^ (cm ² /cm ³) 0 18 ENTER Enclosed space floor width,	Stratum B SCS soil type Lookup Soil Parametern ENTER Enclosed space height,	Stratum B soil dry bulk density, \$\rho_c^B\$ (g/cm^1) 1 5 ENTER Floor-wall seam crack width,	Stratum B soil total porosity, n ⁸ (unitless) 0.43 ENTER Indoor air exchange rate,	Stratum B soil water-filled porosity,	Stratum C SCS soil type Lookup Soil Perameters ENTER Average vapor flow rate into bidg. OR	Stratum C soil dry bulk density, Pb ^C (g/cm ³)	Stratum C soil total porosity, n ^C (unitless)	Stratum C soil water-filled porosity, θ_n^C (cm ³ /cm ³)
. ↓	Stratum A SCS soil type Lookup Soil Paramotorn ENTER Enclosed space floor thickness, Leigh	Stratum A soil dry bulk density, p. ^ (g/cm²) 1.50 ENTER Soil-bldg pressure differential, ΔP	Stratum A soil total porosity, n ^A (unitless) 0.430 ENTER Enclosed space floor length, Le	Stratum A soil water-filled poresity, \$\theta_n^{}\$ (cm^2/cm^2) \$\$\$ 0.18 \$\$\$\$ ENTER Enclosed space floor width, \$\text{W}_{\text{B}}\$\$	Stratum B SCS soil type Lookup Soil Parametern ENTER Enclosed space height, Ha	Stratum B soil dry bulk density, \$\rho_c^B\$ (g/cm^1) 1 5 ENTER Floor-wall seam crack width, W	Stratum B soil total porceity, n ⁸ (unitless) 0.43 ENTER Indoor alr exchange rate, ER	Stratum B soil water-filled porosity,	Stratum C SCS soil type Lookup Soil Perameters ENTER Average vapor flow rate into bidg. OR save blank to calculat Q _{soil}	Stratum C soil dry bulk density, Pb ^C (g/cm ³)	Stratum C soil total porosity, n ^C (unitless)	Stratum C soil water-filled porosity, θ_n^C (cm ³ /cm ³)
MORE +	Stratum A SCS soil type Lookup Soil Paramotorn ENTER Enclosed space floor thickness, Lorge (cm)	Stratum A soil dry bulk density, Pb A (g/cm²) 1 50 ENTER Soil-bidg pressure differential, AP (g/cm·s²)	Stratum A soil total porosity, n ^A (unitless) O.430 ENTER Enclosed space floor length, L _E (cm)	Stratum A Soil water-filled porosity,	Stratum B SCS soil type Lookup Soil Parametern ENTER Enclosed space height, H _B (cm)	Stratum B soil dry bulk density, \(\rho_c^B \) (g/cm^2) 1 5 ENTER Floor-wall seam crack width, w (cm)	Stratum B soil total porosity, n ⁸ (unitiess) 0.43 ENTER Indoor air exchange rate, ER (1/h)	Stratum B soil water-filled porosity,	Stratum C SCS soll type Lookup Soil Perameters ENTER Average vapor flow rate into bidg. OR ave blank to calculat Q _{mol} (L/m)	Stratum C soil dry bulk density, Pb ^C (g/cm ³)	Stratum C soil total porosity, n ^C (unitless)	Stratum C soil water-filled porosity, θ_n^C (cm ³ /cm ³)
MORE V	Stratum A SCS soil type Lookup Soil Paramotorn ENTER Enclosed space floor thickness, Level (cm)	Stratum A soil dry bulk density, p. ^ (g/cm³) 1 50 ENTER Soil-bidg pressure differential, AP (g/cm·s²)	Stratum A soil total porosity. n ^A (unitless) 0.430 ENTER Enclosed space floor length, L _E (cm)	Stratum A soil water-filled porosity, θ_n^A (cm ² /cm ³) 0 18 ENTER Enclosed space floor width, W _B (cm)	Stratum B SCS soil type Lookup Soil Parametern ENTER Enclosed space height, Ha (cm) 366 ENTER	Stratum B soil dry bulk density, p.8 (g/cm³) 1 5 ENTER Floor-wall seam crack width, w (cm)	Stratum B soil total porosity, n ⁸ (unitiess) 0.43 ENTER Indoor air exchange rate, ER (1/h)	Stratum B soil water-filled porosity,	Stratum C SCS soll type Lookup Soil Perameters ENTER Average vapor flow rate into bidg. OR ave blank to calculat Q _{mol} (L/m)	Stratum C soil dry bulk density, Pb ^C (g/cm ³)	Stratum C soil total porosity, n ^C (unitless)	Stratum C soil water-filled porosity, θ_n^C (cm ³ /cm ³)
MORE +	Stratum A SCS soll type Lookup Soil Paramotorn ENTER Enclosed space floor thickness, Lorge (cm) 10 ENTER Averaging	Stratum A soil dry bulk density, p. ^ (g/cm³) 1.50 ENTER Soil-bldg pressure differential, ΔP (g/cm·s²) 40 ENTER Averaging	Stratum A soil total porosity, n ^A (unitless) 0.430 ENTER Enclosed space floor length, L ₆ (cm) 1000 ENTER	Stratum A soil water-filled porosity,	Stratum B SCS soil type Lookup Soil Parametern ENTER Enclosed space height, H _B (cm) 366 ENTER Target	Stratum B soil dry bulk density, p.8 (g/cm³) 1 5 ENTER Floor-wall seam crack width, w (cm) 0 1 ENTER Target hazard	Stratum B soil total porosity, n ⁸ (unitiess) 0.43 ENTER Indoor air exchange rate, ER (1/h)	Stratum B soil water-filled porosity,	Stratum C SCS soll type Lookup Soil Perameters ENTER Average vapor flow rate into bidg. OR ave blank to calculat Q _{mol} (L/m)	Stratum C soil dry bulk density, Pb ^C (g/cm ³)	Stratum C soil total porosity, n ^C (unitless)	Stratum C soil water-filled porosity, θ_n^C (cm ³ /cm ³)
MORE V	Stratum A SCS soil type Lookup Soil Paramotorn ENTER Enclosed space floor thickness, Level (cm)	Stratum A soil dry bulk density, p. ^ (g/cm³) 1 50 ENTER Soil-bidg pressure differential, AP (g/cm·s²)	Stratum A soil total porosity, n ^A (unitless) O.430 ENTER Enclosed space floor length, L _E (cm)	Stratum A Soil water-filled porosity,	Stratum B SCS soil type Lookup Soil Parametern ENTER Enclosed space height, Ha (cm) 366 ENTER	Stratum B soil dry bulk density, p.8 (g/cm³) 1 5 ENTER Floor-wall seam crack width, w (cm)	Stratum B soil total porosity, n ⁸ (unitiess) 0.43 ENTER Indoor air exchange rate, ER (1/h)	Stratum B soil water-filled porosity,	Stratum C SCS soll type Lookup Soil Perameters ENTER Average vapor flow rate into bidg. OR ave blank to calculat Q _{mol} (L/m)	Stratum C soil dry bulk density, Pb ^C (g/cm ³)	Stratum C soil total porosity, n ^C (unitless)	Stratum C soil water-filled porosity, θ_n^C (cm ³ /cm ³)
MORE V	Stratum A SCS soll type Lookup Soil Paramotorn ENTER Enclosed space floor thickness, Lough (cm) 10 ENTER Averaging time for	Stratum A soil dry bulk density, Pb (g/cm²) 1 50 ENTER Soil-bidg pressure differential, AP (g/cm·s²) 40 ENTER Averaging time for	Stratum A soil total porosity, n ^A (unitless) 0.430 ENTER Enclosed space floor length, L _E (cm) 1000 ENTER Exposure	Stratum A soil water-filled porosity,	Stratum B SCS soil type Lookup Soil Parametern ENTER Enclosed space height, Ha (cm) 366 ENTER Target risk for carcinogens, TR	Stratum B soil dry bulk density, p.8 (g/cm³) 1 5 ENTER Floor-wall seam crack width, w (cm) 0 1 ENTER Target hazard quotient for	Stratum B soil total porosity, n ⁸ (unitiess) 0.43 ENTER Indoor air exchange rate, ER (1/h)	Stratum B soil water-filled porosity,	Stratum C SCS soll type Lookup Soil Perameters ENTER Average vapor flow rate into bidg. OR ave blank to calculat Q _{mol} (L/m)	Stratum C soil dry bulk density, Pb ^C (g/cm ³)	Stratum C soil total porosity, n ^C (unitless)	Stratum C soil water-filled porosity, θ_n^C (cm ³ /cm ³)
MORE V	Stratum A SCS soll type Lookup Soil Paramotors ENTER Enclosed space floor thickness, Lorge (cm) 10 ENTER Averaging time for carcinogens,	Stratum A soil dry bulk density, Pb A (g/cm²) 1 50 ENTER Soil-bidg pressure differential, AP (g/cm·s²) 40 ENTER Averaging time for noncarcinogens,	Stratum A soil total porosity, n ^A (unitless) O.430 ENTER Enclosed space floor length, L _E (cm) 1000 ENTER Exposure duration,	Stratum A Soil water-filled porosity,	Stratum B SCS soil type Lookup Soil Parametern ENTER Enclosed space height, H ₆ (cm) 386 ENTER Target risk for carcinogens,	Stratum B soil dry bulk density, \rho_c^R (g/cm^2) 1 5 ENTER Floor-wall seam crack width, w (cm) 0 1 ENTER Target hazard quotient for noncarcinogens,	Stratum B soil total porosity, n ⁸ (unitiess) 0.43 ENTER Indoor air exchange rate, ER (1/h)	Stratum B soil water-filled porosity,	Stratum C SCS soll type Lookup Soil Perameters ENTER Average vapor flow rate into bidg. OR ave blank to calculat Q _{mol} (L/m)	Stratum C soil dry bulk density, Pb ^C (g/cm ³)	Stratum C soil total porosity, n ^C (unitless)	Stratum C soil water-filled porosity, θ_n^C (cm ³ /cm ³)
MORE V	Stratum A SCS soil type Lookup Soil Paramotorn ENTER Enclosed space floor thickness, Lorge (cm) 10 ENTER Averaging time for carcinogens, ATc	Stratum A soil dry bulk density, Pb A (g/cm²) 1 50 ENTER Soil-bidg pressure differential, AP (g/cm·s²) 40 ENTER Averaging time for noncarcinogens, AT _{NC}	Stratum A soil total porosity, n ^A (unitless) O.430 ENTER Enclosed space floor length, Le (cm) 1000 ENTER Exposure duration, ED	Stratum A Soil water-filled porosity,	Stratum B SCS soil type Lookup Soil Parametern ENTER Enclosed space height, Ha (cm) 366 ENTER Target risk for carcinogens, TR	Stratum B soil dry bulk density, \(\rho_E^R \) (g/cm^2) 1 5 ENTER Floor-wall seam crack width, w (cm) 0 1 ENTER Target hazard quotient for noncarcinogens, THO	Stratum B soil total porosity, n ⁸ (unitiess) 0.43 ENTER Indoor air exchange rate, ER (1/h)	Stratum B soil water-filled porosity,	Stratum C SCS soll type Lookup Soil Perameters ENTER Average vapor flow rate into bidg. OR ave blank to calculat Q _{mol} (L/m)	Stratum C soil dry bulk density, Pb ^C (g/cm ³)	Stratum C soil total porosity, n ^C (unitless)	Stratum C soil water-filled porosity, θ_n^C (cm ³ /cm ³)
MORE V	Stratum A SCS soll type Lookup Soil Paramotorn ENTER Enclosed space floor thickness, Loran (cm) 10 ENTER Averaging time for carcinogens, AT _C (yrs)	Stratum A soil dry bulk density, p. ^ (g/cm²) 1.50 ENTER Soil-bidg pressure differential, ΔP (g/cm·s²) 40 ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	Stratum A soil total porosity. n ^A (unitless) 0.430 ENTER Enclosed space floor length, L _E (cm) 1000 ENTER Exposure duration, ED (yrs)	Stratum A soil water-filled porosity,	Stratum B SCS soil type Lookup Soil Parametern ENTER Enclosed space height, Hs (cm) 366 ENTER Target risk for carcinogens, TR (unitless)	Stratum B soil dry bulk density, p.8 (g/cm³) 1 5 ENTER Floor-wall seam crack width, w (cm) 0 1 ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	Stratum B soil total porosity, n ⁸ (unitiess) 0.43 ENTER Indoor air exchange rate, ER (1/h)	Stratum B soil water-filled porosity,	Stratum C SCS soll type Lookup Soil Perameters ENTER Average vapor flow rate into bidg. OR ave blank to calculat Q _{mol} (L/m)	Stratum C soil dry bulk density, Pb ^C (g/cm ³)	Stratum C soil total porosity, n ^C (unitless)	Stratum C soil water-filled porosity, θ_n^C (cm ³ /cm ³)

RESULTS SHEET

71556 / 1.1.1-TCA

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

INCREMENTAL RISK CALCULATIONS:

Indoo exposi groundw conc carcino (µg/L	ure exposure vater groundwater conc., gen noncarcinogen	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc.,	incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA.	NA NA	NA NA	1.33E+06	NA	NA	4.9E-05

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

INCREMENTAL RISK CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	indoor exposure groundwaler conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)	risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitess)
NA NA	NA NA	NA	1.47E+06	NA	7.2E-06	3.8E-03

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

GW-ADV CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box) Version 3.1: 02/04 YES Reset to OR Defaults CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater concluding YES X **ENTER** ENTER Initial groundwater Chemical CAS No conc , (numbers only, C_{w} (μg/L) no dashes) Chemical 127184 9 60E-01 Tetrachloroethylene **ENTER ENTER** ENTER ENTER ENTER ENTER **ENTER** ENTER ENTER ENTER Depth Totals must add up to value of Lyr (cell G28) Sail MORE Average below grade Thickness Thickness stratum A User-defined to bottom Thickness of soil soil/ Depth of soil Soul SCS stratum A of enclosed stratum B. stratum C. groundwater below grade of soil stratum SCS soil type soil vapor temperature, space floor, to water table, stratum A, (Enter value or 0) (Enter value or 0) directly above soil type (used to estimate permeability, T_S بما Lw, hę h_C water table, directly above soil vapor (°C) (Enter A, B, or C) (cm) (cm) (cm) (cm) (cm) water table permeability) (cm²) 200 1300 200 1100 300 10 В 0 SCL ENTER **ENTER ENTER ENTER** ENTER ENTER ENTER ENTER ENTER ENTER ENTER **ENTER** MORE Stratum B Stratum B Stratum A Stratum A Stratum A Stratum A Stratum B Stratum B Stratum C Stratum C Stratum C Stratum C 4 SCS soil dry soil water-filled SCS soil dry soil total soil total soil water-filled SCS soil dry soil total soil water-filled bulk density, soil type bulk density, soil type porosity. porosity, porosity, porosity, porosity, soil type bulk density. porosity, n⁶ nA υ<u>,</u> ^ ρ_t^{E} Lookup Soil ρ_t^A Lookup Soil θ, ^R Lookup Soil 0. ρ_t PAVADIDINA PARADIBLARA Perameters (unitiess) (cm cm) (g/cm) (cm³/cm³) (a/cm³) (unitless) (g/cm³) (unitless) (cm³/cm³) 0.384 0 146 \overline{c} 1 43 SCL 1 63 0 459 0 215 SC 1 63 0 385 0 197 ENTER **ENTER** ENTER ENTER ENTER ENTER ENTER ENTER MORE Enclosed Enclosed Enclosed Average vapor Floor-wall space Soil-bldg space space Enclosed Indoor flow rate into bldg seam crack floor pressure floor floor space air exchange OR Leave blank to calculate thickness, differential. length, width, height, width. rate, ΔΡ We H^{ϵ} ₩ ER Q. Line Lе (g/cm-s²) (1/h) (cm) (cm) (cm) (cm) (cm) (Um) 40 1000 1000 366 01 0 25 10 5 ENTER ENTER ENTER ENTER ENTER MORE ENTER Averaging Target Target hazard Averaging time for time for Exposure Exposure risk for quotient for noncarcinogens, duration, frequency, carcinogens, noncardinogens, carcinogens, ED EF TΑ THO AT_{c} ATAC (unitless) (days/yr) (unitless) (yrs) (yrs) (yrs) 70 30 30 350 1 0E-06 Used to calculate risk-based

groundwater concentration

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

INCREMENTAL RISK CALCULATIONS:

	Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (μg/L)	Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
[NA	NA NA	NA	2.00E+05	NA	1.2E-08	7.7E-06

MESSAGE AND ERROR SUMMARY BELOW. (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

GW-ADV Version 3.1; 02/04	CALCULATE R	ISK-BASED GROU YES	INDWATER CON	ICENTRATION	(enter "X" in "YES"	· box)						
Reset to			OR									
Defaults	CALCULATE IN	ICREMENTAL RISI	KS FROM ACTU	AL GROUNDW	ATER CONCENTE	RATION (enter "X" in	"YES" box and initial	groundwater cond	below)			
		YES	x]								
	ENTER	ENTER										
	Chemical	initial groundwater										
	CAS No	conc.										
	(numbers only,											
	no dashes)	(µg L)	•		Chemical		•					
	71556	1 30E+00]		1,1,1-Trichloroe	thane						
	ENTER	ENTER	ENTER	ENTER	ENTER	ENTER	ENTER	ENTER	ENTER		ENTER	7
		Depth		l otals mu	st add up to value				Soil			
MORE +	Average s oil/	below grade to bottom	Depth	Thickness	Thickness of soil	Thickness of soil	Soll		stratum A SCS		User-defined	L
<u> </u>	groundwater	of enclosed	below grade	of soil	stratum B.	stratum C.	stratum	scs	soil type		stratum A soll vapor	i .
	temperature,	space floor,	to water table,	stratum A,	(Enter value or 0)	(Enter value or 0)	directly above	soil type	(used to estimate	OR	permeability,	ſ
	Tg	L,	لبب₁	h _A	μŧ	ho	water table,	directly above	soll vapor		, k	ļ
	(°C)	(cm)	(cm)	(cm)	(cm)	(cm)	(Enter A, B, or C)	water table	permeability)	•	(cm²)	
	10	200	1300	200	1100	300	В	С	SCL	1		1
										-		-
	ENTER	ENTER	ENTER	ENTER	ENTER	ENTER	ENTER	ENTER	ENTER	ENTER	ENTER	ENTER
MORE	Stratum A	Stratum A	Stratum A	Stratum A	Stratum B	Stratum B	Stratum B	Stratum B	Stratum C	Stratum C	Stratum C	Stratum C
<u> </u>	SCS	soil dry	soil total	soil water-filled		soil dry	soil total	soil water-filled	SCS	soil dry	soli total	soil water-tilled
	soll type	bulk density.	porosity,	porosity.	soil type	bulk density,	porosity,	porosity,	SCS soil type	bulk density,	porosity,	porosity,
	soll type	bulk density.		porosity. ⊕,^^	Soil type	bulk density,		porosity, $\theta_n^{\ \ R}$	Soil type	-		porosity, $\theta_n^{\ c}$
	soll type	bulk density.	porosity,	porosity.	soil type	bulk density,	porosity,	porosity,	eqyt lioa	bulk density,	porosity,	porosity,
	soll type	bulk density.	porosity, n ^A	porosity. ⊕,^^	Soil type	bulk density,	porosity, n ⁶	porosity, $\theta_n^{\ \ R}$	Soil type	bulk density, ρ _ь c	porosity, n ^c	porosity, $\theta_n^{\ c}$
	Soll type Lookup Soll Peranetere	bulk density,	porosity, n ^A (unitiess)	porosity. # (cm³/cm²)	SOI type Lookup Soil Parameterii	bulk density, ρε ^β (g/cm³)	porosity, n ⁶ (unitless)	porosity, $\theta_{\kappa}^{\ R}$ (cm ³ /cm ³)	Soil type Lookup Soil Parameters	bulk density, ρ _b ^c (g/cm³)	porosity, n ^c (unitless)	porosity, θ_w^{C} (cm^3/cm^3)
MORE	SOII type Lookup Soil Paranateia SCL ENTER Enclosed	bulk density,	porosity, n ^A (unitless) 0 384 ENTER Enclosed	porosity. # A (cm³/cm¹) 0 146 ENTER Enclosed	Soil type Lookup Soil Parameteris C ENTEP	bulk density,	porosity, n ^e (unitless) 0 459 ENTER	porosity, θ_n^{R} (cm^3/cm^3) 0 215	SOII type Lookup Sort Perenteles SC ENTER Average vapor	bulk density, ρ _b ^c (g/cm³)	porosity, n ^c (unitless)	porosity, θ_w^{C} (cm^3/cm^3)
	SOII type Lookup Soil Parameterin SCL ENTER Enclosed space	bulk density. Pt (g/cm²) 1 63 ENTER Soil-bidg	porosity, n^ (unilless) 0 384 ENTER Enclosed space	porosity. # A (cm³/cm³) 0 146 ENTER Enclosed space	Soil type Lookup Soil Parameters C ENTEP Enclos J	bulk density, Pr (9/cm³) 1.43 ENTER Floor-wall	porosity, n ^E (unitless) 0 459 ENTER	porosity, θ_n^{R} (cm^3/cm^3) 0 215	SOII type Lookup Sori Peranteless SC ENTER Average vapor flow rate into bidg	bulk density, ρ _b ^c (g/cm³)	porosity, n ^c (unitless)	porosity, θ_w^{C} (cm^3/cm^3)
MORE	soil type Lookup Soil Paranatura SCL ENTER Enclosed space floor	bulk density, \(\rho_t^A\) \(\g/cm^t\) 1 63 ENTER Soil-bidg pressure	porosity, n ^A (unitless) 0 384 ENTER Enclosed space floor	porosity. 9, 4 (cm³/cm³) 0 146 ENTER Enclosed space floor	Soil type Lookup Soil Parameters C ENTEP Enclos J space	bulk density, pr. (g/cm³) 1.43 ENTER Floor-wall seam crack	porosity, n ^E (unitless) 0 459 ENTER Indoor air exchange	porosity, $\theta_n^{\ R}$ (cm ³ /cm ³)	SOII type Lookup Sori Perenteless SC ENTER Average vapor flow rate into bidg OR	bulk density, ρ _b ^c (g/cm ³)	porosity, n ^c (unitless)	porosity, θ_w^{C} (cm^3/cm^3)
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MORE	soil type Lookup Soil Paranatura SCL ENTER Enclosed space floor	bulk density. (p/cm²) 1 63 ENTER Soil-bidg pressure differential.	porosity, n^ (unitless) 0 384 ENTER Enclosed space floor length,	porosity, Handle (cm²/cm²) 0 146 ENTER Enclosed space floor width,	Soil type Lookup Soil Parameters C ENTEP Enclos J space height,	bulk density, pr. (g/cm³) 1.43 ENTER Floor-wall seam crack width,	porosity, n ^E (unitless) 0 459 ENTER Indoor air exchange rate,	porosity, $\theta_n^{\ R}$ (cm ³ /cm ³)	SOII type Lookup Sori Perenteless SC ENTER Average vapor flow rate into bidg OR	bulk density, ρ _b ^c (g/cm ³)	porosity, n ^c (unitless)	porosity, θ_w^{C} (cm^3/cm^3)
MORE	SOII type Lookup Soil Piran atom SCL ENTER Enclosed space floor thickness, Lookup Soil Piran atom Com SCL	bulk density. \(\rho_t^{\text{\text{\$\sigma}}} \) \(\frac{1}{(g/cm^2)} \) 1 63 ENTER Soil-bidg pressure differential, \(\Delta P \) \((g/cm-s^2) \)	porosity, n^ (unitless) 0 384 ENTER Enclosed space floor length, L ₄ (cm)	porosity, th, a (cm²/cm²) 0 146 ENTER Enclosed space floor width, Wt. (cm)	C ENTEP Enclos J space height, H _F (cm)	bulk density, Pt (g/cm³) 1 43 ENTER Floor-wall seam crack width, W (cm)	porosity, n ⁶ (unitless) 0.459 ENTER Indoor air exchange rate, ER (1/h)	porosity, $\theta_n^{\ R}$ (cm ³ /cm ³)	SOII type Lookup Sort Perentwisers SC ENTER Average vapor flow rate into bidg OR ave blank to calcula Quest (L/m)	bulk density, ρ _b ^c (g/cm ³)	porosity, n ^c (unitless)	porosity, θ_w^{C} (cm^3/cm^3)
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MORE V	SOII type Lookup Soil Paranatum SCL ENTER Enclosed space floor thickness, Lookup Soil 10 ENTER	bulk density, Pr A (g/cm²) 1 63 ENTER Soil-bidg pressure differential, ΔP (g/cm-s²) 40 ENTER	porosity, n^ (unitless) 0 384 ENTER Enclosed space floor length, L ₄ (cm)	porosity, th, a (cm²/cm²) 0 146 ENTER Enclosed space floor width, Wt. (cm)	ENTER Entlos J space height, He (cm)	bulk density, Pr (g/cm³) 1.43 ENTER Floor-wall seam crack width, w (cm) 0.1 ENTER	porosity, n ⁶ (unitless) 0.459 ENTER Indoor air exchange rate, ER (1/h)	porosity, $\theta_n^{\ R}$ (cm ³ /cm ³)	SOII type Lookup Sort Perentwisers SC ENTER Average vapor flow rate into bidg OR ave blank to calcula Quest (L/m)	bulk density, ρ _b ^c (g/cm ³)	porosity, n ^c (unitless)	porosity, θ_w^{C} (cm^3/cm^3)
MORE +	SOII type Lookup Soil Paranatum SCL ENTER Enclosed space floor thickness, (cm) 10 ENTER Averaging	bulk density, Pr	porosity, n^ (unitless) 0 384 ENTER Enclosed space floor length, L (cm) 1000 ENTER	porosity, \(\theta_h^A\) (cm^2/cm^4) 0 146 ENTER Enclosed space floor width, \(\psi_+\) (cm) 1000 ENTER	C ENTEP Enclos J space height, He (cm)	bulk density, pr (g/cm³) 1 43 ENTER Floor-wall seam crack width, w (cm) 0 1 ENTER Target hazard	porosity, n ⁶ (unitless) 0.459 ENTER Indoor air exchange rate, ER (1/h)	porosity, $\theta_n^{\ R}$ (cm ³ /cm ³)	SOII type Lookup Sort Perentwisers SC ENTER Average vapor flow rate into bidg OR ave blank to calcula Quest (L/m)	bulk density, ρ _b ^c (g/cm ³)	porosity, n ^c (unitless)	porosity, θ_w^{C} (cm^3/cm^3)
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MORE V	SOII type Lookup Soil Parameteria SCL ENTER Enclosed space floor thickness, Lookup (cm) 10 ENTER Averaging time for carcinogens,	bulk density, \(\rho_t^A \\ \ \ (g/cm^3) \) 1 63 ENTER Soil-bidg pressure differential, \(\delta P \) \((g/cm-s^2) \) 40 ENTER Averaging time for noncarcinogens,	porosity, n^ (unitless) 0 384 ENTER Enclosed space floor length, L (cm) 1000 ENTER	porosity, \(\theta_h^A\) (cm^2/cm^4) 0 146 ENTER Enclosed space floor width, \(\psi_+\) (cm) 1000 ENTER	C ENTEP Enclos J space height, He (cm)	bulk density, pr (g/cm³) 1 43 ENTER Floor-wall seam crack width, w (cm) 0 1 ENTER Target hazard	porosity, n ⁶ (unitless) 0.459 ENTER Indoor air exchange rate, ER (1/h)	porosity, $\theta_n^{\ R}$ (cm ³ /cm ³)	SOII type Lookup Sort Perentwisers SC ENTER Average vapor flow rate into bidg OR ave blank to calcula Quest (L/m)	bulk density, ρ _b ^c (g/cm ³)	porosity, n ^c (unitless)	porosity, θ_w^{C} (cm^3/cm^3)
MORE V	SOII type Lookup Soil Piranatoin SCL ENTER Enclosed space floor thickness, L.,, (cm) 10 ENTER Averaging time for	bulk density. \(\rho_t^A \\ \ \ (g/cm') \) 1 63 ENTER Soil-bidg pressure differential, \(\Delta P \) \((g/cm-s') \) 40 ENTER Averaging time for	porosity, n ^A (unilless) 0 384 ENTER Enclosed space floor length, L4 (cm) 1000 ENTER Exposure duration,	porosity, #h_A^A (cm²/cm²) 0 146 ENTER Enclosed space floor width, Wt, (cm) 1000 ENTER Exposure frequency,	ENTEP Enclos J space height, He (cm) 366 ENTER Target risk for carcinogens,	bulk density, Pt (g/cm³) 1 43 ENTER Floor-wall seam crack width, W (cm) 0 1 ENTER Target hazard quotient for noncarcinogens,	porosity, n ⁶ (unitless) 0.459 ENTER Indoor air exchange rate, ER (1/h)	porosity, $\theta_n^{\ R}$ (cm ³ /cm ³)	SOII type Lookup Sort Perentwisers SC ENTER Average vapor flow rate into bidg OR ave blank to calcula Quest (L/m)	bulk density, ρ _b ^c (g/cm ³)	porosity, n ^c (unitless)	porosity, θ_w^{C} (cm^3/cm^3)
MORE V	SOII type Lookup Soil Parameteria SCL ENTER Enclosed space floor thickness. Lown (cm) 10 ENTER Averaging time for carcinogens, ATc	bulk density, \(\rho_t^A \\ \ \ (g/cm^3) \) 1 63 ENTER Soil-bidg pressure differential, \(\Delta P \) \((g/cm-s^2) \) 40 ENTER Averaging time for noncarcinogens, \(AT_{Nc} \)	porosity, n ^A (unilless) 0 384 ENTER Enclosed space floor length, L ₄ (cm) 1000 ENTER Exposure duration, ED	porosity, #n (cm²/cm²) 0.146 ENTER Enclosed space floor width, Wt. (cm) 1000 ENTER Exposure frequency, EF	Enter Enter Enter Enter Enclos J space height, He (cm) 366 Enter Target risk for carcinogens, TR	bulk density, Pt (g/cm³) 1.43 ENTER Floor-wall seam crack width, w (cm) 0.1 ENTER Target hazard quotient for noncarcinogens, THQ	porosity, n ⁶ (unitless) 0.459 ENTER Indoor air exchange rate, ER (1/h)	porosity, $\theta_n^{\ R}$ (cm ³ /cm ³)	SOII type Lookup Sort Perentwisers SC ENTER Average vapor flow rate into bidg OR ave blank to calcula Quest (L/m)	bulk density, ρ _b ^c (g/cm ³)	porosity, n ^c (unitless)	porosity, θ_w^{C} (cm^3/cm^3)
MORE V	soll type Lookup Soll Parameterin SCL ENTER Enclosed space floor thickness, Lown 10 ENTER Averaging time for carcinogens, AT _C (yrs)	bulk density. Pr (g/cm²) 1 63 ENTER Soil-bidg pressure differential, ΔP (g/cm-s²) 40 ENTER Averaging time for noncarcinogens, AT _{N:} (yrs)	porosity, n^ (unilless) 0 384 ENTER Enclosed space floor length, Le (cm) 1000 ENTER Exposure duration, ED (yrs)	porosity, #n (cm²/cm²) 0 146 ENTER Enclosed space floor width, Wt (cm) 1000 ENTER Exposure frequency, EF (days/yr)	Enclos J space height, Ha (cm) 366 ENTER Target risk for carcinogens, TR (unitless)	bulk density, pr (g/cm³) 1.43 ENTER Floor-wall seam crack width, w (cm) 0.1 ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	porosity, n ⁶ (unitless) 0.459 ENTER Indoor air exchange rate, ER (1/h)	porosity, $\theta_n^{\ R}$ (cm ³ /cm ³)	SOII type Lookup Sort Perentwisers SC ENTER Average vapor flow rate into bidg OR ave blank to calcula Quest (L/m)	bulk density, ρ _b ^c (g/cm ³)	porosity, n ^c (unitless)	porosity, θ_w^{C} (cm^3/cm^3)

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

INCREMENTAL RISK CALCULATIONS:

Indoor exposure conc carcinogen	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)	incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA .	NA NA	NA	1.33E+06	NA NA	NA	3.2E-06

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION 5 77 WEST JACKSON BOULEVARD CHICAGO, IL 60604-3590

MEMORANDUM

DATE:

February 2, 2005

SUBJECT:

Request for Screening Vapor Intrusion Analysis - Ellsworth Industrial

Park, Downers Grove, IL (Site ID B52A)

FROM:

Ross del Rosario, RPM

TO:

Arunas Draugelis, Toxicologist

I am requesting a screening analysis for potential vapor intrusion of contaminants from monitoring and residential wells around the Ellsworth Industrial Park, per our discussion yesterday. Attached you will find pertinent data to assist you in completing the analysis. In addition to the attached, please use the following data as part of your calculation:

Residential Well Data:

Hydraulic Conductivity:

GW Flow:

TCE - 16.6 ug/L

16.6 ug/L

0.0016 ft/ft

South-Southeast

PCE - 14.0 ug/L

1,1,1 TCA - 6.3 ug/L

I would like you to provide me with a <u>transmittal memo</u> containing the following information:

- Printouts/output from modeling exercise you performed using both the monitoring well and residential well data, using the calculated hydraulic conductivity and geological data provided;
- 2. Your evaluation of the output data. To the extent you are able to, please elaborate if vapor intrusion is a real or potential problem at this location;
- 3. Recommendation(s) or conclusion(s), if any, you may have after evaluating the data.

Your assistance on this matter is greatly appreciated. Due to importance of this analysis on the project, I would like to have your transmittal memo completed no later than February 8, 2005. Thank you.

Table 4-4 (continued) AREA 7 Tricon Property

(All units in ug/L)

6 1 14 16	77 (0)	700 1500	22 1002
Sample Identification	BD-16(D)	BD-17(D)	BD-18(D)
Depth (feet)	74-84	81-91	81-91
Date Sampled	6/19/02	6/20/02	6/20/02
Parameter			
1,1,1 TCA	1.3		
1,1-DCA	***		
1,1 - DCE			
cis 1,2 DCE		3.2	
trans 1,2 DCE			
Tetrachloroethene (PCE)	0.69 J	0.96 J	
Trichloroethene (TCE)	40	13	
Acetone			
2-Butanone			-
Toluene			-
1,24- Trimethylbenzene			
Ethyl Benzene			200
m/p xylene	***		
o-xylene			
Dichlorodifluoromethane			
Iodomethane			
Naphthalene	•••		

^{--- -} not detected.

Bob Kay/R5/USEPA/US

02/01/2005 04:43 PM

To ROSAURO DELROSARIO/R5/USEPA/US@EPA

CC

bcc

Subject Ellsworth request

Ross--I've looked over some the well logs for the residential wells in the residential area around the Ellsworth site and the geology, in a VERY general way, looks as follows (all depths in feet from ground surface)

0-1 topsoil 1-60 clay 60-120 sand and gravel or clay 120 and beyond bedrock

if you figure the average basement has a depth of about 8-10 feet, that means in most of this area there's something like 50 ft or so of low-permeability material between the VOCs dissolved in the ground water and the bottom of someone's basement.

Table 2. Well information and water levels in select residential-supply wells in the vicinity of the Ellsworth Industrial Site, Downer's Grove, Illinois, September 23-24, 2003. [?-unknown; Bold denotes uncertain of accuracy; BR, bedrock aquifer; >, greater than; <, less than]

111.50

108.98

RW25

RW26

759.55

757.15

September 22-23, 2003 October 12, 2004 Water-Level Water-Level Measuring-Point Altitude (feet Altitude (feet above sea Depth to Water Altitude (feet Depth to Water above sea Depth of Open Well Geophysical Change Logs? (feet) level) (feet) level) Interval (feet) above sea level) (feet) name 98.10 646.51 97.15 647.46 115-140 RW1 744.61 0.95 112.25 RW2 760.20 647.95 111.50 648.70 128-180 0.75 645.69 65.73 ? 711.79 66.10 646.06 0.37 RW3 98.66 ?-240 101.19 646.25 648.78 RW4 747.44 2.53 126.27 644.53 RW5 770.80 65.28 65.90 651.45 652.07 106-185 0.62 RW6 717.35 643.89 125.25 RW7 129.20 647.84 ? 773.09 3.95 92.00 647.92 91.15 ? RW8 648.77 0.85 739.92 648.20 81.35 RW9 730.39 82.19 649.04 0.84 **RW10** 101.39 644.16 98.25 647.30 3.14 745.55 100.75 646.80 **RW11** 747.55 **RW12** 738.36 90.62 647.74 88.15 650.21 2.47 <645.57 98.62 **RW13** 745.57 >101 646.95 ? 645.21 **RW14** 744.91 99.70 648.38 ? **RW15** 94.45 649.13 743.58 95.20 0.75 101.60 643.60 97.75 647.45 110-160 **RW16** 745.20 3.85 **RW17** 119.40 648.37 118.70 649.07 120-205 0.70 767.77 88.82 89.66 648.34 649.18 102-185 0.84 **RW18** 738.00 **RW19** 116.62 643.47 111.38 648.71 100-? 5.24 760.09 97.67 96.95 647.24 **RW20** 646.52 115-140 0.72 744.19 652.81 105.14 647.47 -5.34 99.80 111-175 **RW21** 752.61 **RW22** 115.09 650.00 116.45 648.64 110-190 -1.36 765.09 648.28 116.60 649.01 117.33 120-205 0.73 **RW23** 765.61 91.10 647.47 645.52 120-140 1.95 **RW24** 738.57 93.05 648.05 130-175

648.17

108.30

648.85

120-170

0.68

RW27	748.39	104.10	644.29	99.85	648.54	126-185	4.25
RW28	763.47	120.05	643.42	115.75	647.72	126-205	4.30
RW29	754.57	112.74	641.83	110.98	643.59	144-185	1.76
RW30	742.81	94.50	648.31	-	•	116-175	-
RW31	749.00	104.90	644.10	-	-	128-171	-
RW32	757.86	112.85	645.01	-	-	105-150	-
RW33	763.32	121	642.32	114.55	648.77	120-205	6.45
RW34	731.09	86.20	644.89	•	-	?	•
RW35	755.8 9	108.31	647.58	107.57	648.32	125-163	0.74

.

Table 1. Well information and water-level data from select monitoring wells, Ellsworth Industrial site, Downers Grove, Illinois. [NT, not taken; -, unavailable; Bold denotes uncertain value]

					Septemb	er 23, 2003	October 12, 2004	
	Geologic Depos Monitored by	it Measuring Point Altitude (feet	Depth of Screen	Altitude of Bottom of Open Interval (feet above sea	Depth to	Water-Level Altitude (feet above sea	Depth to	Water-Level Altitude (feet above sea
Well	Well	above sea level)	Interval (feet)	level)	Water (feet)	level)	Water (feet)	level)
BD-11	Drift	696.56	27-37	662	25.12	671.44	-	•
BD-1D	Bedrock	696.25	60-70	626	46.62	649.63	-	-
BD 41	Drift	701.65	47-57	645	43.01	658.64	43.52	658.13
BD 4D	Bedrock	701.83	71-81	620	52.48	649.35	51.95	649.88
BD 51	Drift	689.05	37-47	642	32.52	656.53	32.15	656.90
BD 5D	Bedrock	689.31	54-64	622	39.38	649.93	38.67	650.64
BD 6I	Drift	692.91	45-50	643	43.01	649.9	42.34	650.57
BD 6D	Bedrock	692.97	64-74	619	43.29	649.68	42.63	650.34
BD 7I	Drift	690.02	36-46	644	32.96	657.06	32.59	657.43
BD 7D	Bedrock	689.64	60-70	620	40.37	649.27	39.42	650.22
BD 8I	Drift	689.86	35-45	645	39.19	650.67	38.71	651.15
BD 8D	Bedrock	690.00	68-78	610	40.22	649.78	39.57	650.43
<u>BD 91</u>	<u>Drift</u>	<u>715.19</u>	<u>37-42</u>	<u>673</u>	<u>dry</u>		<u>45.30</u>	669.89
BD 9D	Bedrock	715.12	79-89	623	63.91	651.21	63.18	651.94
BD 10D	Bedrock	717.35	79-89	628	66.26	651.09	65.47	651.88
BD-11D	Bedrock	703.69	94-104	600	-	-	•	-
BD 12D	Bedrock	700.30	78-88	612	51.20	649.1	50.60	649.70
<u>BD 131</u>	<u>Drift</u>	<u>701.46</u>	<u>41-46*</u>	<u>634</u>	<u>7.44</u>	694.02	<u>-</u>	-
BD 13D	Bedrock	701.46	79-89	612	52.56	648.9	51.84	649.62
BD 141	Drift	698.73	42-47	651	dry	<651	46.80	651.93
BD 14D	Bedrock	699.28	73-83	616	48.39	650.89	47.65	651.63
BD 16D	Bedrock	705.36	74-84	621	56.90	648.46	56.15	649.21
SB 17I	Drift	694.96	35-45	650	<u>37.85</u>	657.11	<i>63.09</i>	631.87
BD 18D	Bedrock	706.85	81-91	616	63.80	643.05	57.26	649.59
OV6I	Drift	693.60	40-50	644	-	-	43.25	650.35
BD-15I	drift	690.22	35-45	645	-	-	-	-
DG-11	top bedrock	688.31	20-30	668	-	•	28.41	659.90
DG-1D	top bedrock	686.94	35-45	642	-	-	27.21	659.73
DG-2I	top bedrock	698.62	47-57	641	-	•	42.17	656.45

DG-3I	top bedrock	701.56	50-60	641	-	-	48.89	652.67
DG-4I	top bedrock	703.77	50-60	643	-	-	53.41	650.36
DG-5l	top bedrock	694.34	50-60	634	-	-	44.20	650.14
DG-6I	top bedrock	697.93	50-60	638	-	-	46.67	651.26
DG-15l	mid-drift	702.92	55-6 5	637	-	-		702.92
SB-15I	top bedrock	702.09	32-37	665	-	-	34.34	667.75
LD-11		708.03	54-64	644	-	-	58.22	649.81

PARSONS

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Fax + 312-8810-4071	Fax #

4

March 21, 2002

Mr. Stan Komperda
Project Manager
Illinois Environmental Protection Agency
Bureau of Land
1021 North Grand Avenue East
Springfield, Illinois 62794-9276

Re: Groundwater/Enclosed Space Inhalation Risk Evaluation

Lockformer Site, Lisle, Illinois

Dear Mr. Komperda:

In response to your recent comments, Parsons is pleased to provide the following summary of our evaluation of the inhalation risk posed by groundwater containing dissolved concentrations of trichloroethene (TCE) in the vicinity of the Lockformer site in Lisle, Illinois.

SUMMARY OF ANALYSIS

Parsons performed inhalation risk evaluation using the ASTM 1739-95 Risk-Based Corrective Action standard, Section X2.5, Ground Water – Inhalation of Enclosed-Space (Indoor) Vapors. This methodology was used to estimate the inhalation risk in the basement of a theoretical private residence located directly above a groundwater plume of TCE in a subsurface lithology consistent with that of the Lockformer site in Lisle, Illinois. Attachment A includes the relevant pages from the ASTM standard that were used in evaluating this risk. Attachment B contains the specific work sheets developed by Parsons, which include all of the assumed input parameters used in this evaluation and the referenced source for each parameter.

A detailed description of the calculation methodology is included below. In summary, the ASTM analysis indicates that at the maximum concentrations at which TCE has been detected in a private well in the vicinity of the Lockformer site (~20 ppb), the contribution to inhalation cancer risk is less than 1 x 10⁻⁶. Specifically, our analysis was performed using three assumed groundwater concentrations for TCE: 10 parts per billion (ppb), 50 ppb, and 1,000 ppb (or 1 part per million, ppm). The table below shows the resulting inhalation cancer risk posed by each of these assumed concentrations:

TCE Concentration (ug/l)	Inhalation Cancer Risk
10	2.03 x 10 ⁻⁷
50	1.02 x 10 ⁻⁶
1,000	2.03 x 10 ⁻⁵

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Mr. Stan Komperda March 21, 2002 Page 2

LIMITATIONS OF ANALYTICAL METHODOLOGY

Having supplied the results of our analysis above, we feel it is also important to point out the significant limitations of the analytical method described in the ASTM standard. A quick perusal of the attached worksheets shows the significant number of assumptions that need to be made in order to complete this analysis. The geometry of the lithology, the depth at which the TCE plume is traveling laterally, and the specific geometry of the foundation cracks through which TCE vapors are assumed to enter the indoor space all factor significantly into the results of this analysis; none of these input parameters to the analytical model are known with any degree of certainty for the Lockformer site.

For reasons explained in more detail in the following section, the analysis is particularly sensitive to the thickness of the capillary fringe layer, or in the particular ease of the Lockformer site, to the thickness of uncontaminated water that may exist above the horizon at which the TCE plume may be traveling laterally in bedrock. (This sensitivity is related to the fact that any thickness of uncontaminated groundwater will significantly inhibit the diffusion of TCE in an upward direction). An illustration of this model sensitivity is shown in the table below. Three different thicknesses of an uncontaminated, inhibiting groundwater layer were assumed. The corresponding TCE source concentration related to an inhalation risk of 10⁻⁶ was then calculated. As shown by the table below; the thickness of this groundwater layer is roughly proportional to the source TCE concentration corresponding to a risk level of 10⁻⁶.

Assumed Thickness of Inhibiting Groundwater Layer (ft)	TCE Concentration Corresponding to 10 ⁻⁶ Inhalation Risk (ug/l)
1	10.6
5	49.2
10	97.5

Because the inhalation risk level varies so significantly with the variation of the inhibiting groundwater layer (an unknown parameter at the Lockformer site), it is important to view the results of our analysis through the context of this limitation. Still, the variation in risk level varies primarily in a conservative manner; i.e., the risk level is likely less than 10⁻⁶ in the vicinity of the Lockformer site, given all of the currently available information.

DETAILED DISCUSSION OF ANALYSIS

The chemical characteristics of TCE used in the analysis were obtained from Part 742, Illinois Administrative Code. Most of remaining input parameters were obtained directly from the ASTM standard. The inhalation cancer slope factor for TCE was provided by the IEPA.

Mr. Stan Komperda March 21, 2002 Page 3

The site-specific parameters used in the calculations are depth to groundwater, thickness of the capillary fringe layer, and the thickness of the vadose zone. In our analysis, the air and water volumetric content of the pore space within the capillary fringe layer were modified to reflect the most likely transport mechanisms of the TCE plume at the Lockformer site.

Figure 1 in Attachment A shows modeling assumptions regarding the definition of depth to groundwater, thickness of the capillary fringe, and the thickness of the vadose zone. It is assumed in this model that the constant source of dissolved contamination is already present at the top of the water table and that no diffusion transport is needed for contamination to reach the top of groundwater table from this constant source.

Transport characteristics through soil and the capillary fringe zone depend on the thickness of the zone, the air and water volumetric content of the pore space within the zone, and the compound diffusivity through air and water. The effective diffusion coefficient is a measure for the combined effect of these factors. The air diffusivity coefficient for TCE is several orders of magnitude higher than the corresponding water diffusivity coefficient.

For that reason, the effective diffusion through the capillary fringe zone (containing mostly water) is significantly lower than the effective diffusion coefficient for the vadose zone (containing mostly air). The resulting overall effective diffusion coefficient (calculated for the entire zone over which diffusion takes place) depends most significantly on the thickness of the layer with the smallest diffusion coefficient (the capillary fringe layer). Accordingly, the thickness of this capillary fringe layer is a much more significant input parameter than the thickness of the vadose zone through which the TCE must diffuse.

For the purposes of this analysis, Parsons assumed that the TCE plume has traveled laterally through a network of bedrock fractures to the off-site residential neighborhood, and that at least some of the groundwater in the saturated zone above the bedrock (and beneath the private residences) has not been affected (as would be the case if the release of TCE had originated from directly above). This conclusion has yet to be proven with actual data, but is a reasonable assumption given the likely transport mechanisms of the off-site TCE plume.

The attached evaluation assumes that the constant source of dissolved contamination in bedrock is approximately 5 feet below the groundwater surface. Based on currently available data, this is a conservative assumption (i.e., the thickness of uncontaminated groundwater may be more than 5 feet). Parsons treated this 5-foot layer as a capillary fringe layer by adjusting the volumetric content of soil vapor for this layer to zero to reflect the fact that the entire 5-foot thickness is completely saturated with water.

SUMMARY OF ANALYSIS

Overall, our analysis of the available data using the best available models leads us to conclude that TCE groundwater concentrations above 50 ppb at the Lockformer site could potentially contribute to an inhalation cancer risk greater than 1×10^{-6} ; however, the highest groundwater TCE concentration actually observed in the vicinity of the Lockformer site is less

Mr. Stan Komperda March 21, 2002 Page 4

than this level (~20 ppb). It should also be noted that the limitations of the calculation methodology should not be ignored; the results of this analysis are very sensitive to changes in input parameters, and our conclusion should only be viewed as a preliminary conclusion based upon the available data. The only way to confidently and quantifiably determine the inhalation risk in the private residences would be through a systematic and empirical air sampling program in the vicinity of the Lockformer site.

We appreciate the opportunity to provide you with this analysis. Please call Mr. Sasa Jazic at any time if you have questions related to this letter, or should require any other additional assistance.

Sincerely,

PARSONS CORPORATION

Sasa Jazic

Project Engineer

Richard M. Frendt, P.E.

Technical Director

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cc:

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ATTACHMENT A
ASTM 1739-95
Ground Water – Inhalation of Enclosed-Space (Indoor) Vapors

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tions and parameters used to prepare the example look-up Table X2.1. The basis for each of these equations is discussed in X2.2 through X2.10.

X2.2 Air—Inhalation of Vapors (Outdoors/Indoors)—In this case chemical intake results from the inhalation of vapors. It is assumed that vapor concentrations remain constant over the duration of exposure, and all inhaled chemicals are absorbed. Equations appearing in Tables X2.2 and X2.3 for estimating RBSLs for vapor concentrations in the breathing zone follow guidance given in Ref (26). Should the calculated RBSL exceed the saturated vapor concentration for any individual component, "> P_{uap} " is entered in the table to indicate that the selected risk level or hazard quotient cannot be reached or exceeded for that compound

and the specified exposure scenario.

X2.3 Ground Water—Ingestion of Ground Water—In this case chemical intake results from ingestion of ground water. It is assumed that the dissolved hydrocarbon concentrations remain constant over the duration of exposure. Equations appearing in Tables X2.2 and X2.3 for estimating RBSLs for drinking water concentrations follow guidance given in Ref (26) for ingestion of chemicals in dripking water. Should the calculated RBSL exceed the pure component solubility for any individual component, ">S" is entered in the table to indicate that the selected risk level or hazard quotient cannot be reached or exceeded for that compound and the specified exposure scenario (unless free-phase product is mixed with the ingested water).

TABLE X2.2 Equations Used to Develop Example Tier 1 Risk-Based Screening Level (RBSLs) Appearing in "Look-Up" Table X2.1— Carcinagenic Effects⁴

AL	ables X2.4 through X2.7 for definition of paramete	Carcinagenic Effects ⁴
Medium	Exposure Route	Risk-Based Screening Level (RBSL)
u .	inhalation ^g	$ABSL_{ar} \left[\frac{\mu g}{m^2 - ar} \right] = \frac{TR \times BW \times AT_c \times 365 \frac{days}{years} \times 10^3 \frac{\mu g}{mg}}{SF_c \times IR_{ar} \times EF \times ED}$
Ground water	ingestion (potable ground water supply only) ⁸	$RBSL_{w}\left[\frac{m_{Q}}{L-H_{2}O}\right] = \frac{TR \times BW \times AT_{c} \times 365}{SF_{o} \times IR_{w} \times EF \times ED}$
Pround water c	enclosed-space (Indoor) vapor inhalation ^o	$RBSL_{w}\left[\frac{mg}{LH_{z}O}\right] = \frac{RBSL_{w}\left[\frac{\mu g}{m^{3}-ah}\right]}{VF_{max}} \times 10^{-3} \frac{mg}{\mu g}$
Bround water c	amblent (outdoor) vapor inhalation ^o	$RBSL_{w}\left[\frac{mg}{L+H_{g}O}\right] = \frac{RBSL_{ab}\left[\frac{\mu g}{m^{3}-air}\right]}{VF_{wamb}} \times 10^{-3} \frac{mg}{\mu g}$
Burficial soit	ingestion of soil, inhalation of vapors and particulates, and dermal contact*	$RBSL_{s} \left[\frac{\mu_{0}}{\log_{e} soll} \right] = \frac{TR \times BW \times AT_{o} \times 365}{\text{years}} \frac{\text{days}}{\text{years}}$ $EF \times ED \left[\left(SF_{o} \times 10^{-4} \frac{\text{kg}}{\text{mg}} \times (IR_{sol} \times RAF_{o} + SA \times M \times RAF_{o}) \right) + (SF_{o} \times IR_{sol} \times (VF_{so} + VF_{p})) \right]$
		For s:-ficial and excavated soits (0 to 1 m)
Mitteurface soil ^c	ambient (outdoor) vapor inhalation ^p	$RBSL_{a} \left[\frac{mg}{kg \cdot eo''} \right] = \frac{RBSL_{ab} \left[\frac{\mu g}{m^{3} \cdot ab'} \right]}{VF_{nemb}} \times 10^{-3} \frac{mg}{\mu g}$
Absuriace soil ^c	enclosed space (Indoor) vapor inhelation ^p	$RBSL_{a}\left[\frac{mg}{kg\text{-eol}t}\right] = \frac{RBSL_{av}\left[\frac{\mu g}{m^{3}\text{-air}}\right]}{VF_{avep}} \times 10^{-3} \frac{mg}{\mu g}$
neurtace soto	leaching to ground water ^p	$RBSL_{*}\left[\frac{mg}{kg\text{-eoff}}\right] = \frac{RBSL_{*}\left[\frac{mg}{LH_{2}O}\right]}{LF_{av}}$

(Note that all RBSL values should be compared with thermodynamic partitioning limits, such as solubility levels, maximum vapor concentrations, and so forth. If a RBSL solubility levels maximum vapor concentrations, and so forth. If a RBSL solubility levels maximum vapor concentrations, and so forth. If a RBSL solubility levels, maximum vapor concentrations, and so forth. If a RBSL solubility levels, maximum vapor concentrations, and so forth. If a RBSL solubility levels, maximum vapor concentrations, and so forth. If a RBSL solubility levels, maximum vapor concentrations, and so forth. If a RBSL solubility levels, maximum vapor concentrations, and so forth. If a RBSL solubility levels, maximum vapor concentrations, and so forth. If a RBSL solubility levels, maximum vapor concentrations, and so forth. If a RBSL solubility levels, maximum vapor concentrations, and so forth. If a RBSL solubility levels, maximum vapor concentrations, and so forth. If a RBSL solubility levels, maximum vapor concentrations, and so forth. If a RBSL solubility levels, maximum vapor concentrations, and so forth. If a RBSL solubility levels, maximum vapor concentrations, and so forth. If a RBSL solubility levels, maximum vapor concentrations, and so forth.

Screening levels for these media based on other considerations (for example, seathetic, background levels, environmental resource protection, and so forth) can be listed with these equations by substituting the selected target level for RBSL, or RBSL, appearing in these equations.

These equations are based on Ref (26).
These equations simply define the "cross-media partitioning factors," VF_V and LF_{sor}

TABLE X2.4 Exposure Parameters Appearing in Tables X2.2 and X2.3

Parameters	Definitions, Units	Residential	Commercial/Industrial
AT _e	averaging time for carcinogens, years	70 years	70 years^
IT.	averaging time for noncarcinogens, years	30 years	25 years 4
3W	adult body weight, kg	70 kg	70 kg^
D	exposure duration, years	30 years	25 years ⁴
F	exposure frequency, days/years	350 days/year	250 days/yeer^
Past	sof ingestion rate, mg/day	100 mg/day	50 mg/day^
-Indoor	dally indoor inhalation rate, m ⁵ /day	15 m³/day	20 m³/day^
-ouldoor	daily outdoor inhalation rate, m3/day	20 m³/day	20 m⊒day^
R.	daily water ingestion rate, L/day	2 L/day	1 L/day^
F	leaching factor, (mg/L-H ₂ O)/(mg/kg-soil)—see Table X2.5	chemical-specific	chemical-specific
,	soil to skin adherence factor, mg/cm²	0.5	0.5
WFa	dermal relative absorption factor, volatiles/PAHs	0,5/0.05	0.5/0.05
WF.	oral relative absorption factor	1.0	1.0
BSL,	risk-based screening level for media I, mg/kg-soll, mg/L-H ₂ O, or µg/m³-sir	chemical-, media-, and exposure route-specific	chemical-, media-, and exposure route-specific
ro,	inhalation chronic reference dose, mg/kg-day	chemical-specific	chemical-apacific
rD.	oral chronic reference dose, mg/kg-day	chemical-specific	chemical-specific
'A "	skin surface area, cm ² /day	3160	31604
F,	inhalation cancer slope factor, (mg/kg-day)=1	chemical-specific	chemical-specific
F.	oral cancer slope factor, (mg/kg-day)-1	chemical-specific	chemical-specific
HO	target hazard quotient for individual constituents, unitiess	1.0	1.0
A	target excess individual Metime cancer risk, unitiess	for example, 10 ⁻⁴ or 10 ⁻⁴	for example, 10 ⁻⁶ or 10 ⁻⁴
F,	volatilization factor, (mg/m²-air)/(mg/kg-soif) or (mg/m²-air)/(mg/ L-H ₂ O)—see Table X2.5	chemical- and media-specific	chemical- and media-specific

⁴ See Ref (27).

surface,

~T /1@ 1

X2.4.2.4 No loss of chemical as it diffuses towards ground surface (that is, no biodegradation), and

X2.4.2.5 Steady well-mixed atmospheric dispersion of the emanating vapors within the breathing zone as modeled by a "box model" for air dispersion.

X2.4.3 Should the calculated RBSL, exceed the pure component solubility for any individual component, ">S" is entered in the table to indicate that the selected risk level or hazard quotient cannot be reached or exceeded for that compound and the specified exposure scenario.

X2.5 Ground Water—Inhalation of Enclosed-Space (Indeer) Vanors:

X2.5.1 In this case chemical intake results from the inhalation of vapors in enclosed spaces. The chemical vapors originate from dissolved hydrocarbons in ground water located some distance below ground surface. Here the goal is to determine the dissolved hydrocarbon RBSL that corresponds to the target RBSL for vapors in the breathing zone, as given in Tables X2.2 and X2.3. If the selected target vapor concentration is some value other than the RBSL for inhalation (that is, odor threshold or ecological criterion), this value can be substituted for the RBSL_{air} parameter appearing in the equations given in Tables X2.2 and X2.3.

X2.5.2 A conceptual model for the transport of chemicals from ground water to indoor air is depicted in Fig. X2.2. For simplicity, the relationship between enclosed-space air and dissolved ground water concentrations is represented in Tables X2.2 and X2.3 by the "volatilization factor" VF_{wesp} [(mg/m³-air)/(mg/L-H₂O)] defined in Table X2.5. It is based on the following assumptions:

X2.5.2.1 A constant dissolved chemical concentration in ground water,

X2.5.2.2 Equilibrium partitioning between dissolved chemicals in ground water and chemical vapors at the ground water table,

X2.5.2.3 Steady-state vapor- and liquid-phase diffusion

through the capillary fringe, vadose zone, and foundation cracks,

X2.5.2.4 No loss of chemical as it diffuses towards ground surface (that is, no biodegradation), and

X2.5.2.5 Steady, well-mixed atmospheric dispersion of the emanating vapors within the enclosed space, where the convective transport into the building through foundation cracks or openings is negligible in comparison with diffusive transport.

X2.5.3 Should the calculated RBSL_w exceed the pure component solubility for any individual component, ">S" is entered in the table to indicate that the selected risk level or hazard quotient cannot be reached or exceeded for that compound and the specified exposure scenario.

X2.6 Surficial Soils—Ingestion, Dermal Contact, and Vapor and Particulate Inhalation:

X2.6.1 In this case it is assumed that chemical intake results from a combination of intake routes, including: ingestion, dermal absorption, and inhalation of both particulates and vapors emanating from surficial soil.

X2.6.2 Equations used to estimate intake resulting from ingestion follow guidance given in Ref (26) for ingestion of chemicals in soil. For this route, it has been assumed that surficial soil chemical concentrations and intake rates remain constant over the exposure duration.

X2.6.3 Equations used to estimate intake resulting from dermal absorption follow guidance given in Ref (26) for dermal contact with chemicals in soil. For this route, it has been assumed that surficial soil chemical concentrations and absorption rates remain constant over the exposure duration.

X2.6.4 Equations used to estimate intake resulting from the inhalation of particulates follow guidance given in Ref (26) for inhalation of airborne chemicals. For this route, it has been assumed that surficial soil chemical concentrations, intake rates, and atmospheric particulate concentrations remain constant over the exposure duration.

X2.6.5 Equations used to estimate intake resulting from

⁸ See Ref (28)

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the inhalation of airborne chemicals resulting from the volatilization of chemicals from surficial soils follow guidance given in Ref (26) for inhalation of airborne chemicals.

X2.6.6 A conceptual model for the volatilization of chemicals from surficial soils to outdoor air is depicted in Fig. X2.3. For simplicity, the relationship between outdoor air and surficial soil concentrations is represented in Tables

X2.2 and X2.3 by the "volatilization factor" VF_{xx} [(mg/m³-air)/(mg/kg-soil)] defined in Table X2.5. It is based on the following assumptions:

X2.6.6.1 Uniformly distributed chemical throughout the depth 0-d (cm) below ground surface,

X2.6.6.2 Linear equilibrium partitioning within the soil matrix between sorbed, dissolved, and vapor phases, where

TABLE X2.5 Volatifization Factors (VF_i), Leaching Factor (LF_{ew}), and Effective Diffusion Coefficients (D_i^{ew})

Symbol	Cross-Media Route (or Definition)	Equation
VFuss	Ground water → enclosed-epace vapors	$VF_{unexp} \left[\frac{(mg/m^2 - air)}{(mg/L - H_2 O)} \right] = \frac{H \left[\frac{D^{ad}/L_{conv}}{ER L_0} \right]}{1 + \left[\frac{D^{ad}/L_{conv}}{ER L_0} \right] + \left[\frac{D^{ad}/L_{conv}}{(D^{ad}/L_{conv})^2} \right]} \times 10^3 \frac{L}{m^3} ^{A}$
VF _{ware}	Ground water → ambient (outdoor) vapors	$VF_{wave} \left[\frac{(mg/m^2 \cdot air)}{(mg/L \cdot H_2O)} \right] = \frac{H}{1 + \left[\frac{U_{air} h_{air} L_{ow}}{WD_{air}^{air}} \right]} \times 10^3 \frac{L}{m^3}$
VF _{aa}	Surficial soils → ambient air (vapors)	$VF_{ac}\left[\frac{(mg/m^3-eir)}{(mg/kg-eoit)}\right] = \frac{2W\rho_a}{U_{ab}\delta_{abr}} \cdot \sqrt{\frac{D_a^{ab}H}{\pi(\theta_{mg}+k_a\rho_a+H\theta_{ac})\tau}} \times 10^3 \frac{cm^3-kg}{m^3-g} c$ or: $VF_{ac}\left[\frac{(mg/m^3-eir)}{(mg/kg-eoit)}\right] = \frac{W\rho_a d}{U_{ab}\delta_{abr}} \times 10^3 \frac{cm^3-kg}{m^3-g}; \text{ whichever is Tess}^{a}$
VF,	Surficial soits → ambient air (particulates)	$VF_{\rho}\left[\frac{(mg/m^2-air)}{(mg/cg-acit)}\right] = \frac{\rho_{\phi}W}{U_{ab}\delta_{air}} \times 10^3 \frac{cm^2-log}{m^2-g} e^{it}$
VF _{eemo}	Subsurface soils → ambient air	$VF_{\text{partit}}\left[\frac{(\text{mg/m}^2-\text{air})}{(\text{mg/kg-eoff})}\right] = \frac{H\rho_e}{\left[\theta_{\text{evg}} + K_{\text{a}}\rho_e + H\theta_{\text{as}}\right]\left(1 + \frac{U_{\text{ab}}\delta_{\text{air}}L_S}{D_e^{\text{air}}W}\right)} \times 10^3 \frac{\text{cm}^3\text{-kg}}{\text{m}^3\text{-g}} F$
VFores	Subsurface soil → enclosed-space vapors	$VF_{anno} \left[\frac{(mg/m^{3}-ah')}{(mg/kg-coil)} \right] = \frac{H\rho_{o}}{\left\{ \theta_{o,o} + k_{p}\theta_{o} + M\theta_{aa} \right\}} \left[\frac{O_{o}^{ah'}/L_{g}}{ER L_{g}} \right] \times 10^{3} \frac{cm^{3}-kg}{m^{3}-g} A$ $1 + \left[\frac{O_{o}^{ah'}/L_{g}}{ER L_{g}} \right] + \left[\frac{O_{g}^{ah'}/L_{o}}{(O_{o}^{ah}/L_{o}-ah)^{3}} \right] \times 10^{3} \frac{cm^{3}-kg}{m^{3}-g} A$
	Subsurface soils → ground water	$LF_{av}\left[\frac{(mg/L+H_aO)}{(mg/kg-aoN)}\right] = \frac{\rho_0}{\left[\theta_{ava} + k_a\rho_a + H\theta_{ava}\right]\left(1 + \frac{U_{gw}k_{gw}}{IW}\right)} \times 10^0 \frac{\text{cm}^3 \cdot \text{kg}}{L \cdot \text{g}} \text{ s}$
D _e ee	Effective diffusion coefficient in soil based on vapor-phase concentration	$D_{g}^{m}\left[\frac{\cos^{2}}{s}\right] = D^{m}\frac{R_{g}^{23}}{R_{f}^{2}} + D^{m}\frac{1}{H}\frac{R_{g}^{23}}{4L}$
D off Grands	Effective diffusion coefficient through foundation cracks	$D_{\text{cross}}^{\text{eff}} \left[\frac{\text{OTT}^2}{s} \right] = D^{\text{art}} \frac{\theta_{\text{activate}}^{2.25}}{\theta_{\text{s}}^2} + D^{\text{eff}} \frac{1}{H} \frac{\theta_{\text{activate}}^{2.20}}{\theta_{\text{s}}^4} \wedge $
0.5	Effective diffusion coefficient through capitary frings	Ost (
D#	Effective diffusion coefficient between ground water and soil surface	$D \stackrel{\text{def}}{=} \left[\frac{\text{cross}^2}{\text{s}} \right] = \left(h_{\text{cross}} + h_{\text{o}} \right) \left[\frac{h_{\text{cross}}}{D_{\text{cross}}^{\text{def}}} + \frac{h_{\text{v}}}{D_{\text{o}}^{\text{cross}}} \right]^{-1} A$
C:-	Soil concentration at which dissolved pore-water and vapor phases become saturated	$C_{\mu}^{\text{and}} \left[\frac{\text{mg}}{\text{kg-soft}} \right] = \frac{S}{\rho_{o}} \times \left[H \theta_{aa} + \theta_{ave} + k_{a} \rho_{a} \right] \times 10^{0} \frac{L - \text{g}}{\text{cm}^{3} - \text{kg}} \rho$

[^] See Ref (29).

[#] See Ref (30).

G See Ref (31).

^p Based on mass balance.

[#] See Ref (32).

[&]quot; See Ref (33).

JABLE X2.6 Soil, Building, Surface, and Subsurface Parameters Used in Generating Example Tier 1 RBSLs

NOTESee	X2.10 for	CETHICETION OF	OWN STORY	selection.
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Parameter	Definitions, Units	Residential	Commercial/Industrial
ď	lower depth of surficial soil zone, om	100 on	100 cm
O=+	diffusion coefficient in air, cm ² /s	chemical-specific	chemical-specific
Ower	diffusion coefficient in water, cm²/s	chemical-specific	chemical-specific
ER	enclosed-space air exchange rate, L/s	0.00014 4-1	0.00023 s-1
l _{ec}	traction of organic carbon in soil, g-C/g-soil	0.01	0.01
H	herry's law constant, (cm ² -H ₂ O)/(cm ² -air)	chemical-specific	ohemical-specific
how	thickness of capitlery fringe, orn	5 cm	€ forn
h _w	thickness of vadose zone, on	295 cm	295 cm
1	infiltration rate of water through soil, cm/years	30 cm/year	_30 cm/year
k _{ee}	cerbon-water scription coefficient, cm ² H _e O/g-C	chemical-specific	chemical-specific
k,	sof-water sorption coefficient, cm ² -H ₂ O/g-soll	$l_{ac} \times k_{ac}$	lac × kac
L _B	enclosed-apace volume/infiltration area ratio, cm	200 cm	300 cm
Lorent	enclosed-space foundation or wall thickness, cm	15 cm	15 cm
Law	depth to ground water = hee + hm cm	300 cm	300 cm
Ls	depth to subsurface soil sources, om	100 cm	100 cm
ρ.	perticulate emission rate, g/cm²-e	6.9 × 10 ⁻¹⁴	6.9 × 10 ⁻¹⁴
s	pure component solubility in water, mg/L-H ₂ O	chemical-specific	chemical-specific
U	wind speed above ground surface in ambient mixing zone, cm/s	225 cm/s	225 cm/s
U_m	ground water Darcy velocity, onlyeer	2500 cm/year	2500 cm/year
w	width of source area parallel to wind, or ground water flow direction, orn	1500 cm	1500 cm
644	ambient air mixing zone height, cm	200 cm	200 cm
i	ground water mixing zone thickness, cm	200 cm	200 cm
य व	areal fraction of cracks in foundations/walls, cm2-cracks/cm2-total area	0.01 cm ² -cracks/cm ² -total area	0.01 cm2-cracks/cm2-total area
P _{acep}	volumetric air content in capitlary fringe soils, cm ³ -air/cm ³ -soil	0.038 cm ³ -air/cm ³ -soil	0.38 cm³-air/cm³-soil
Pecreck	volumetric air content in foundation/wall cracks, cm3-air/cm3 total volume	0.26 cm ³ -air/cm ³ total volume	9:26 tim3-air/cm3 total volume
f	volumetric air content in vadoes zone solls, cm3-air/cm3-soil	0.26 cm³-sir/cm³-soil	0.26 cm ³ -air/cm ³ -soil
17	total soil porosity, cm3/cm3-soil	0.38 cm³/cm³-soil	0.38 cm³/cm²-soli
P _{woop}	volumetric water content in capitary tringe soils, cm ² H ₂ O/cm ² -soil	0.342 cm3-H ₂ O/cm3-soil	0.342 cm ³ -H ₂ O/cm ³ -soil
l _{wortek}	volumetric water content in foundation/wail cracks, cm ³ -H ₂ O/cm ³ total volume	0.12 cm ³ -H ₂ O/cm ³ total volume	0.12 cm3-H ₂ O/cm3 total volume
1	volumetric water content in vadose zone soils, cm ² H ₂ O/cm ² -soil	0.12 cm ³ -H _e O/cm ³ -soli	0.12 cm ² -H ₂ O/cm ² -soil
ρ.	soil bulk density, g-eoil/cm ^a -soil	1.7 g/cm ³	1.7 g/cm ³
7	averaging time for vapor flux, s	7.88 × 10 ^e s	7.68 × 10 ⁶ s

the partitioning is a function of constant chemical- and soil-specific parameters,

X2.6.6.3 Diffusion through the vadose zone,

X2.6.6.4 No loss of chemical as it diffuses towards ground surface (that is, no biodegradation), and

X2.6.6.5 Steady well-mixed atmospheric dispersion of the emanating vapors within the breathing zone as modeled by a "box model" for air dispersion.

X2.6.7 In the event that the time-averaged flux exceeds that which would occur if all chemical initially present in the surficial soil zone volatilized during the exposure period,

then the volatilization factor is determined from a mass balance assuming that all chemical initially present in the surficial soil zone volatilizes during the exposure period.

X2.7 Subsurface Soils—Inhalation of Outdoor Vapors:

X2.7.1 In this case chemical intake is a result of inhalation of outdoor vapors which originate from hydrocarbons contained in subsurface soils located some distance below ground surface. Here the goal is to determine the RBSL for subsurface soils that corresponds to the target RBSL for outdoor vapors in the breathing zone, as given in X2.2. If the selected target vapor concentration is some value other than

TABLE X2.7 Chemical-Specific Properties Used in the Derivation Example Tier 1 RBSLs

Chemical	CAS Number	M_ g/mol	H, L-H, O/L-et	D ^{ab} , om ² /s	Dw, cm²/s	log(K _{ee}). L/kg	log(K _{ow}), L/kg
Benzene	71-43-2	78^	0.22^	0.0934	1.1 × 10-44	1,584	2.13^
Tokene	106-66-3	924	0.26^	0.0854	9.4 × 10 ⁻⁴⁰	2.13^	2.65^
Ethyl benzene	100-00-3	106^	0.32^	0.0764	8.5 × 10-40	1.98^	3.13^
•		106^	0.29^	0.0720	8.5 × 10-40	2.384	3.26^
Mixed xylenes	1330-20-7	128^	0.049^	0.0720	9.4 × 10-44	3.114	3.284
Naphthelene Benzo(a)pyrene	91-20-3 50-32-8	252°	5.8 × 10 ^{-4.8}	0.0500	5.8 × 10-40	5.59 <i>€</i>	5.98
Chemical	CAS No		SF _a kg-day/mg	SF, kg-dey/mg	RfD₀, m	g/kg-day	RfD _i , mg/kg-day
Benzane	71-43	2	0.029F	0.029°			***
Totuene	108-8	_	• • •		0.2		0.11
Ethyl benzene	100-4	-			0.1		0.29*
Mixed xylenes	1330-			***	2.0		2.0*
Nachthalana	91-20-				0.0	004°	0.004
Benzo(a)pyrene	50-32	-	7.3 ^F	6.1 <i>F</i>	<u> </u>	<u> </u>	···

^A See Ref (34).

^{*} See Ref (35). * See Ref (7).

Diffusion coefficient calculated using the method of Fuller, Schettler, and Glddings, from Ref (11).

E Calculated from $K_{\rm ow}/K_{\rm or}$ correlation: $\log(K_{\rm oc}) \approx 0.937 \log(K_{\rm ow}) - 0.006$, from Ref (11).

[&]quot; See Ref (2).

O See Ref (3).

the RBSL for inhalation (that is, odor threshold or ecological criterion), this value can be substituted for the $RBSL_{air}$ parameter appearing in the equations given in Tables X2.2 and X2.3.

X2.7.2 A conceptual model for the transport of chemicals from subsurface soils to ambient air is depicted in Fig. X2.4. For simplicity, the relationship between outdoor air and soil concentrations is represented in Tables X2.2 and X2.3 by the "volatilization factor," VF_{samb} [(mg/m³-air)/(kg-soil)], defined in Table X2.5. It is based on the following assumptions:

X2.7.2.1 A constant chemical concentration in subsurface soils,

X2.7.2.2 Linear equilibrium partitioning within the soil matrix between sorbed, dissolved, and vapor phases, where the partitioning is a function of constant chemical- and soil-specific parameters,

X2.7.2.3 Steady-state vapor- and liquid-phase diffusion through the vadose zone to ground surface,

X2.7.2.4 No loss of chemical as it diffuses towards ground surface (that is, no biodegradation), and

X2.7.2.5 Steady well-mixed atmospheric dispersion of the emanating vapors within the breathing zone as modeled by a "box model" for air dispersion.

X2.7.3 Should the calculated RBSL, exceed the value for which the equilibrated vapor and dissolved pore-water phases become saturated, C_i^{sat} [mg/kg-soil] (see Table X2.5 for calculation of this value), "RES" is entered in the table to indicate that the selected risk level or hazard quotient cannot be reached or exceeded for that compound and the specified exposure scenario (even if free-phase product or precipitate is present in the soil).

X2.8 Subsurface Soils—Inhalation of Enclosed-Space (Indoor) Vapors:

X2.8.1 In this case chemical intake is a result of inhalation of enclosed-space vapors which originate from hydrocarbons contained in subsurface soils located some distance below ground surface. Here the goal is to determine the RBSL for subsurface soils that corresponds to the target RBSL for indoor vapors, as given in Tables X2.2 and X2.3. If the selected target vapor concentration is some value other than the RBSL for inhalation (that is, odor threshold or

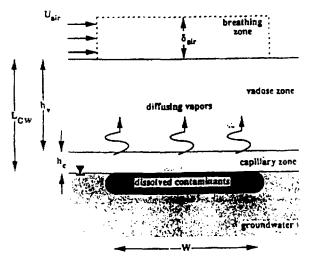
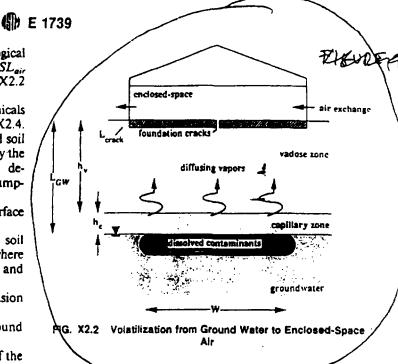


FIG. X2.1 Volatilization from Ground Water to Ambient Air



ecological criterion), this value can be substituted for the RBSL_{air} parameter appearing in the equations given in Tables X2.2 and X2.3.

X2.8.2 A conceptual model for the transport of chemicals from subsurface soils to enclosed spaces is depicted in Fig. X2.5. For simplicity, the relationship between indoor air and soil concentrations is represented in Tables X2.2 and X2.3 by the "volatilization factor," VF_{sexp} [(mg/m³-air)/(kg-soil)], defined in Table X2.5. It is based on the following assumptions:

X2.8.2.1 A constant chemical concentration in subsurface soils,

X2.8.2.2 Linear equilibrium partitioning within the soil matrix between sorbed, dissolved, and vapor phases, where the partitioning is a function of constant chemical- and soil-specific parameters,

X2.8.2.3 Steady-state vapor- and liquid-phase diffusion through the vadose zone and foundation cracks,

X2.8.2.4 No loss of chemical as it diffuses towards ground surface (that is, no biodegradation), and

X2.8.2.5 Well-mixed atmospheric dispersion of the emanating vapors within the enclosed space.

X2.8.3 Should the calculated RBSL_s exceed the value C_s^{sat} [mg/kg-soil] for which the equilibrated vapor and dissolved pore-water phases become saturated (see Table X2.5 for calculation of this value), "RES" is entered in the table to indicate that the selected risk level or hazard

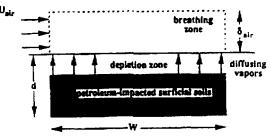


FIG. X2.3 Volatilization from Surficial Soils

ATTACHMENT B CALCULATION WORKSHEETS

हारारा व

CALCULATION OF SITE-SPECIFIC GROUNDWATER SCREENING LEVEL FOR ENCLOSED-SPACE VAPORS PROTECTION

Private Residence Vicinity of Lockformer Facility Lisie, Illinois

4

Chemical Compound: Trichloroethylene

INPUT PARAMETERS			-
Scenario-Specific Paramet	ers .		
	Description		Source
	Scenario Type		
	Target Cancer Risk		ASTM
	Adult Body Weight		ASTM
	Averaging Time for Carcinogens		ASTM
	Daily Indoor Inhelation Rate		ASTM
	Exposure Frequency		ASTM
	Exposure Duration		ASTM
Compound-Specific Parame	ters	Ţ <u></u>	
	Description		Source

			pecific Parameters	
Parameter	Value	Units	Description	Source
Compound	Trichlomethylene		Name of Chemical Compound	
SFI	4.00E-01	(mg/kg-d)-1	Inhalation Cancer Slope Factor	IEPA
Н'	0.42	(unitiess)	Henry's Law constant	TACO
Dair	0.079	(cm2/s)	Diffusion Coefficient in Air	TACO
Dwater	9.1E-08	(cm2/s)	Diffusion Coefficient in Water	TACO

		Site-	Specific Parameters	
Parameter	Value	Units	Description	Source
nl	0.01	(unitiess)	Areal Fraction of Cracks in Foundations/Watts	ASTM
ER	0.00014	(s-1)	Enclosed-Space Air Exchange Rate	MTEA
Lgw	1525	(cm)	Depth to Groundwater	S
Lb	200	(cm)	Enclosed-Space Volume/Infiltration Area Ratio	ASTM
Lorack	15	(cm)	Enclosed-Space Foundation or Walt Thickness	ASTM
hcap	152	(cm)	Thickness of Capitary Fringe	S
hv	1373	(cm)	Thickness of Vadore Zone	S
nws	0.12	(unitiess)	Volumetric Water Content in Vadose Zone Soils	ASTM
nas	0.26	(unitless)	Volumetric Air Content in Vadose Zone Solls	ASTM
n	0.38	(unitiess)	Total Soil Porosity	ASTM
пусар	0.38	(unitiess)	Volumetric Water Content in Capitary Fringe Solis	5
пасар	0	(unitiess)	Volumetric Air Content in Capilary Fringe Sots	<u>.</u> s
nwcrack	0.12	(unitless)	Volumetric Water Content in Foundation/Wall Cracks	ASTM
nagrack	0.26	(unitless)	Volumetric Air Content in Foundation/Wall Cracks	ASTM

S	Site Specific Parameter
ASTM	ASTM Standard E 1739-95
TACO	Table E, Default Physical/Chemical Parameters, Part 742, June 1998
IEPA	Value provided by the IEPA
Eq	Value calculated by previous equation

Parameter

Scenario TR

BW

ATc

(Rair-Indoor

EF

ED

Value

Residential

1E-06

70

70

15

350

30

Units

unitiess

(hg)

(m3/d)

(d/yr)

(yr)

Page 1

CALCULATION OF SITE-SPECIFIC GROUNDWATER SCREENING LEVEL FOR ENCLOSED-SPACE VAPORS PROTECTION

Private Residence Vicinity of Lockformer Facility Liele, (liinois

4

Chemical Compound: Trichloroethylene

		CAL	CULATED PARAMETERS	
	Effective Di	ffusion Coefficient is	n Soli Based on Vapor-Phase Concentration (Ds-eff)	
Input Parameters	Value	Units	Description	Source
Dair	0.079	(cm2/s)	Diffusion Coefficient in Air	TACO
Owater	9.10E-08	(cm2/s)	Diffusion Coefficient in Water	TACO
Н'	0.422	(unitiess)	Henry's Law constant	TACO
NWS	0.12	(unitiess)	Volumetric Water Content in Vadose Zone Solls	ASTM
nas	0.26	(unitiese)	Volumetric Air Content in Vadose Zone Soils	ASTM
n	0.38	(unitiese)	Total Soll Porcelty	ASTM
Calculated Parameter	Value	I belta I	Paradattan	
Ds-eff	Value 6.14E-03	Units (cm2/s)	Description Effective Diffusion Coefficient In Soil	Source Eq.
	Effect	ive Diffusion Cosmic	clent through Foundation Cracks (Ocrack-eff)	
Input Parameters	Value	Units	Description	Source
Dair	0.079	(cm2/s)	Diffusion Coefficient in Air	TACO
Dwater	9.100000000E-08	(cm2/s)	Diffusion Coefficient in Water	TACO
H	0.422	(unitiess)	Henry's Law constant	TACO
nwcrack	0.12	(unitiess)	Volumetric Water Content in Foundation/Wall Cracks	ASTM
nacrack	0.26	(unitiess)	Volumetric Air Content in Foundation/Wall Cracks	ASTM
n	0.38	(unitiess)	Total Soil Porosity	ASTM
		Units	Description	Source
Calculated Parameter	Value !			
n				
				
Calculated Parameter Dorack-off	Value 6.14E-83	(cm2/s)	Effective Diffusion Coefficient through Foundation Cracks	Eq.
	6.14E-83 Eff	ective Diffusion Coe	Effective Diffusion Coefficient through Foundation Crucks fficient through Capitary Fringe (Deap-eff)	Eq.
Dorack-off Input Parameters	6.14E-03 Eff Value	ective Diffusion Coe	Effective Diffusion Coefficient through Foundation Crucks fficient through Capitary Fringe (Deap-eff) Description	Eq.
Dorack-off Input Parameters Deir	6.14E-93 Eff Value 0.079	Units (om2/s)	Effective Diffusion Coefficient through Foundation Crucks fficient through Capitary Fringe (Deap-eff) Description Diffusion Coefficient in Air	Source TACO
Dorack-off Input Parameters Dair Dwater	\$.14E-93 Eff Value 0.079 9.10E-08	Units (cm2/s) (cm2/s)	Effective Diffusion Coefficient through Foundation Crucks fficient through Capitary Frings (Doap-eff) Description Diffusion Coefficient in Air Diffusion Coefficient in Water	Source TACO TACO
Derack-off Input Parameters Dair	\$.14E-93 Eff Value 0.079 9.10E-08 0.422	Units (cm2/s) (cm2/s) (unitess)	Effective Diffusion Coefficient through Foundation Crucks fficient through Capitary Frings (Dosp-eff) Description Diffusion Coefficient in Air Diffusion Coefficient in Water Henry's Law constant	Source TACO TACO
Dorack-off Input Parameters Deir Dwater	6.14E-93 Eff Value 0.079 9.10E-08	Units (cm2/s) (cm2/s) (unitess)	Effective Diffusion Coefficient through Foundation Crucks fficient through Capitary Frings (Dosp-eff) Description Diffusion Coefficient in Air Diffusion Coefficient in Water Henry's Law constant Volumetric Water Content in Capitary Fringe Solis	Source TACO TACO TACO S
Dorack-off Input Parameters Deir Dwater H'	\$.14E-93 Eff Value 0.079 9.10E-08 0.422	Units (cm2/s) (cm2/s) (unitess)	Effective Diffusion Coefficient through Foundation Cracks officient through Capitary Fringe (Dcap-eff) Description Diffusion Coefficient in Air Diffusion Coefficient in Water Henry's Law constant Volumetric Water Content in Capitary Fringe Soils Volumetric Air Content in Capitary Fringe Soils	Source TACO TACO TACO S S
Dorack-off Input Parameters Deir Dwater H' nwcap	Value 0.079 9.10E-08 0.422 0.38	Units (cm2/s) (cm2/s) (unitess)	Effective Diffusion Coefficient through Foundation Crucks fficient through Capitary Frings (Dosp-eff) Description Diffusion Coefficient in Air Diffusion Coefficient in Water Henry's Law constant Volumetric Water Content in Capitary Fringe Solis	Source TACO TACO TACO S
Dorack-off Input Parameters Deir Dwater H' nwcap nacap	Value 0.079 9.10E-08 0.422 0.38	Units (cm2/s) (cm2/s) (unitiess) (unitiess)	Effective Diffusion Coefficient through Foundation Cracks officient through Capitary Fringe (Dcap-eff) Description Diffusion Coefficient in Air Diffusion Coefficient in Water Henry's Law constant Volumetric Water Content in Capitary Fringe Soils Volumetric Air Content in Capitary Fringe Soils	Source TACO TACO TACO S S

S	Site Specific Parameter
ASTM	ASTM Standard E 1739-95
TACO	Table E, Default Physical/Chemical Parameters, Part 742, June 1998
IEPA	Value provided by the IEPA
C-	Value calculated by pravious equation

Page 2

CALCULATION OF SITE-SPECIFIC GROUNDWATER SCREENING LEVEL FOR ENCLOSED-SPACE VAPORS PROTECTION

Private Residence Vicinity of Lockformer Facility Lisle, Illinois

Chemical Compound: Trichloroethylene

		CA	LCULATED PARAMETERS	
	Effect	ive Diffusion Coefficie	nt between Groundwater and Boll Surface (Dws-eff)	
Input Perameters	Value	Units	Description	Source
hcap	152.4	(cm)	Thickness of Capillary Fringe	S
hv	1372.6	(cm)	Thickness of Vadose Zone	S
Dcap-eff	5.94E-08	(cm2/s)	Effective Diffusion Coefficient through Capitary Fringe	Eq
Ds-eff	6.14E-03	(cm2/s)	Effective Diffusion Coefficient in Soil	Eq.
Calculated Parameter	Value	Units	Description	Source
Dws-eff	5.89E-05	(cm2/s)	Effective Diffusion Coefficient between Groundwater and Soil Surface	Eq.
Input Parameters	Value	<u> </u>	Description	Source
H'	0.422	(unitiess)	Henry's Law constant	TACC
Dws-eff	5.89E-05	(cm2/s)	Effective Diffusion Coefficient between Groundwater and Soil Suiface	Eq
Lgw	1525	(cm)	Depth to Groundweter	S
ER	0.00014	(8-1)	Enclosed-Space Air Exchange Rate	ASTN
Lb	200	(c:n)	Enclosed-Space Volume/Infiltration Area Ratio	ASTN
Dcrack-eff	6 14E-03	(cm2/e)	Effective Diffusion Coefficient through Foundation Cracks	Eq.
Lorack	15	(cm)	Enclosed-Space Foundation or Wall Thickness	ASTN
ni	0.01	(unitiess)	Areal Fraction of Cracks in Foundations/Walls	ASTN
Calculated Parameter	Value	Units	Description	Source
VFwesp	5.77E-04	(mg/m3)/(mg/L)	Groundwater - Enclosed Space Vapors Volatilization Factor	Eq.
		Risk-Based Sc	reaning Level for inhalation (RBSLair)	
Input Parameters	Value	Units	Description <u>d</u>	Source
TR	1E-08	unitiess	Target Cancer Risk	ASTA
8W	70	(kg)	Adult Body Weight	ASTA
ATC	70	(years)	Averaging Time for Carcinogens	ASTA
tRair-Indoor	15	(m3/d)	Daily Indoor Inhalation Rate	ASTR
	350	(d/yr)	Exposure Frequency	ASTR
EF		(yr)	Exposure Duration	AST
ED				1500
	0.4	(mg/kg-d)-1	Inhelation Cencer Slope Factor	IEPA
ED				Soun

S	Site Specific Parameter
ASTM	ASTM Standard E 1739-95
TACO	Table E. Default Physical/Chemical Parameters, Part 742, June 1998
IEPA	Value provided by the IEPA
Eq	Value calculated by previous equation

Page 3

CALCULATION OF SITE-SPECIFIC GROUNDWATER SCREENING LEVEL FOR ENCLOSED-SPACE VAPORS PROTECTION

Private Residence Vicinity of Lockformer Facility Lisle, Minois

Chemical Compound: Trichloroethylene

		CAL	CULATED PARAMETERS	
Risk-Based Screening Level for Enclosed-Space Vapor Inhelation (RBSLw)				
Input Parameters	Value	Units	Description	Source
RBSLsir	2.84E-02	(ug/m3)	Risk-Based Screening Level for inhalation	Eq.
VFwesp	5.77E-04	(mg/m3)/(mg/L)	Groundwater - Enclosed Space Vapors Volatilization Factor	Eq.
Calculated Parameter	Value	Unite	Description	Source
RBSLW	4.92E-02	(mg/L)	Risk-Based Screening Level for Enclosed-Space Vapor Inhalation	Eq.

S	Site Specific Parameter
ASTM	ASTM Standard E 1739-95
TACO	Table E, Default Physical/Chemical Parameters, Part 742, June 1998
IEPA	Value provided by the IEPA
Eq	Value calculated by previous equation

Page 4

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